

CHEMICAL & METALLURGICAL ENGINEERING

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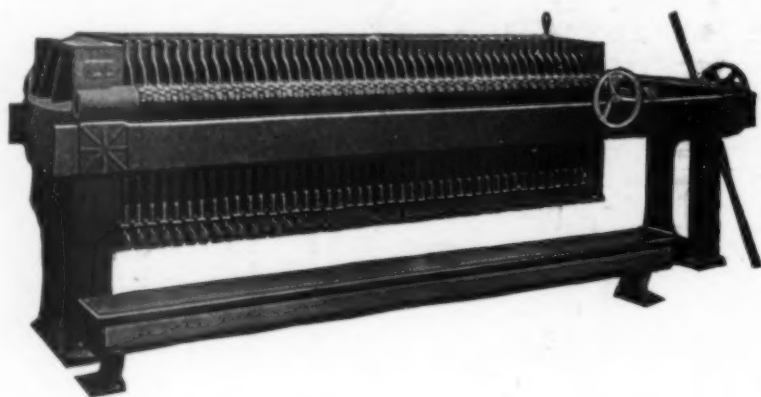
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Laying the Foundation For Our Foreign Trade

NOT all the news that comes from Washington these days is proving a menace to business. Happily the recent rumors that the Department of Commerce is to receive an increased appropriation have at last been confirmed. The Senate Committee on Commerce has reported out a bill which, if finally approved, will give the Bureau of Foreign and Domestic Commerce about \$450,000 more than its appropriation of last year. To be sure, \$750,000 had been asked by Mr. HOOVER and this amount had received the approval of the Director of the Budget, but in view of the tight-fisted policies of the present Congress on all except vote-getting expenditures, the country can well rejoice at the committee's apparent far-sightedness.

It is to be hoped that this is the beginning of a broader view of our foreign trade. Consular service and other active agencies for trade information lie at the very foundation of commerce and logically that is where we should begin to build. The dominating overseas trade of Great Britain and pre-war Germany had been developed around consular and commercial services that formed a network extending to the four quarters of the globe. England in particular has spent centuries in developing sources of trade information and keeping the avenues of commerce open to her merchants.

It is largely to these activities that the British merchant marine owes its enviable development. With merchants and agents in every port selling and urging the sale of British goods, the groundwork was laid for a foreign trade which naturally was carried in British vessels. Perhaps our own lawmakers may yet realize that subsidies for American shipping and government extension of credits are necessary only because we have neglected our foreign commerce. An intensive study of foreign markets is logically the first step in reconstructing our fast diminishing export trade.

An additional justification of the increased appropriation for the Department of Commerce is to be found in the program awaiting the recently authorized foreign debt commission. The recommendations of this commission in regard to the ten billion dollars now owed to the United States must be based on accurate knowledge of economic conditions in Europe. Naturally its members will look to Secretary HOOVER and his department for much of this essential information.

Finally, the chemical industry has its own selfish reasons for rejoicing. Secretary HOOVER's plans for enlarging the work of his department call for a number of new commodity divisions and among the first to be established will be the one devoted to the dye and chemical industries. The need for this division is already evident and we are looking forward patiently

to its organization. The increase in appropriations, which will make possible these extended activities, must yet be approved by the Senate and agreed to by the conferees, but it is hoped that the good work once started will proceed to its completion.

"Free Information Service"

SOME consulting chemical engineers have apparently had misgivings over the recent announcement by the National Research Council of "free information service." They have thought this announcement was an evidence that the Council was about to enter into competition with them and encroach upon the legitimate field by free consulting service. If this were the fact, there would be great point in the comment which has been made; but fortunately it is quite clear that such is not the Council's intent.

The Research Information Service, which made the announcement referred to, is one of the divisions of the Council. Its purpose is to assist investigators by answering questions or placing these investigators in touch with sources of information from which aid of any sort may be had. Many times the ability to get a needed fact, a needed reference, a needed piece of apparatus, will accelerate research tremendously. Indeed, this may be sufficient to permit continuance of work that otherwise would be abandoned through discouragement of the investigator. One of the purposes of the Service is to supply such assistance. In this effort it should inspire the commendation of all.

In general the Service is being extended only slightly beyond the field of assistance to the private individual or the investigator in collegiate work. Its effort in technical and commercial problems is limited by the meager funds available. In most cases the queries which come to the Council would not otherwise go to any commercial or consulting agency. But by assistance to the few industrial inquirers who ask aid, the Information Service undertakes primarily to build up an appreciation of and a desire for more results of research. And where the inquirer appears to be a firm or individual who should make use of professional consultants, reference is made to such sources.

Free service by the Council, an endowed quasi-public body, in competition with the consulting profession would be inexcusable. The Council recognizes this fact. Instead, it desires to build up the most friendly co-operative arrangement with the consulting profession at large. Indeed, it hopes that the appreciation of research and the stimulus to research from its work will be such as to increase the demand for consulting service and thus make more widespread the use of experienced and competent advisers. On this basis certainly the consulting profession can co-operate.

The Chemist And the Lawyer

ON FEBRUARY 13 last *The Financier* of London published an article several columns in length on "Chemicals and Chemical Engineering." The purpose was to show the rapid rise of British chemical industry under the stress of war, the ubiquitous need of the chemist throughout industry, the prompt and efficient answer that the British chemist made to the call for his services, and the gradual let-down that has taken place in British chemical industry since the war.

All we need to do is to change a few names and the article would be timely here. The reason for the let-down we believe to be the same in both countries. It is only partly economic. Another very potent cause applies, we believe, to both American and British chemists in similar measure, and we propose to look for it among the chemists themselves rather than among manufacturers or purchasers of materials or the general public.

The relation of the chemist to industry is substantially the same as that of the lawyer to business. The lawyer draws contracts and provides for the avoidance of error in transactions. With his aid associations are formed and selling and distribution are carried on. But the chemist produces the goods. Why is it, then, that the actual producer of goods is a kind of hired man, as often as not required to punch the time-clock, while the lawyer receives the manufacturer in his own office, charges him a month's salary of a chemist for an hour's discussion and a letter in relation to matters of less importance than the work of the chemist?

During the war the chemist, being needed, was exalted until he scarcely knew himself. His advice was constantly asked for and taken, and he sat in the seats of the mighty. The war over, he finds himself in most cases back in the position of a hired man again. Why is it?

It is not competition that does it, for there are more lawyers than chemists, and there is, in point of fact, more real work for chemists to do than there is for lawyers. True, there is a certain glamour, a tradition of distinction, that attaches itself to the legal profession which is lacking in that of chemistry, but in spite of this, the profession of law has many members who are unfit for decent society; a large number of them have no background of culture whatever. On the other hand, there are always enough lawyers of eminence and prominence to maintain the tone; to keep up what the Chinese call the "face" of the profession; to present a very taking front.

Chemists are lacking in this quality of well-knownness among their number, and the question is fair whether they have not principally themselves to blame. If we consider the relations of present-day lawyers to public affairs compared to that of present-day chemists, it looks almost as though chemists were not interested. There is one chemist in the U. S. Senate, and we have lately read of a professor of chemistry who is president of a local chamber of commerce. We are disposed to make a fuss over it as a triumph. Instead of being a triumph it is a confession.

How many American chemists are there who can speak with the grace, the *savoir faire*, the distinction of Dr. EDGAR FAHS SMITH? If there are any they are remarkably silent! The literature of chemistry is no more technical or uninteresting to the layman than

that of law. But men who make this very legal literature are wanted for every possible activity all the time, while nobody knows about the chemists.

We believe the era of chemistry will come about when chemists assume a great obligation to the general welfare; when they guide public opinion by expressing themselves with such facility that everyone can understand, while the substance of their discourse is of value to the public.

This is not to be brought about by a publicity agent or by propaganda. It will come as a result of constant and useful public service, and from the quality of public teaching that begets understanding and faith.

The Haber Process Pinned Down to Facts

ASIDE from its importance from the military standpoint and to the agricultural and fertilizer interests, the fixation of nitrogen by the Haber process has been of peculiar interest to the chemical industry since its commercialization in 1913, partly because it came to us so thoroughly labeled "Made in Germany." An air of mystery has been thrown around the details of the process and we have been regaled by stories of the Krupp superlathe which turn out tremendous seamless tubes of a marvelous new alloy for the German plants. Most of the mystery has been dispelled by the practical experience at Sheffield and today the Haber process is established on a commercial scale in America. Some residue of the original fascination, however, makes the subject of lively general interest, while those actively participating in the recent development eagerly seek reliable detailed information on different phases of the process.

It is therefore with an appreciation of their value that we call attention to the series of articles reporting the work of the Fixed Nitrogen Research Laboratory on the synthesis of ammonia which begins on another page of this issue. As an example of truly scientific research, these experiments might well be cited as a model. The laboratory has made a thorough study of the various ammonia catalysts and the general principles and problems involved in the synthesis. It is with the latter that the present series deals particularly. Among other problems, the increasing conversion with rising temperature, counteracted at a certain point by the increased rate of decomposition, presents an interesting study of great industrial importance. Again, the effect of pressure, temperature, rate of flow and catalyst poisons in the gas have been studied under conditions which made possible the accuracy of the research laboratory, yet which are unusually comparable to operating practice. It is well known that the chief difficulty in the Haber process has been the proper mechanical construction of the plant to withstand the action of the gases under the necessary high pressures. For this reason the detailed descriptions of the small-scale testing plants developed in these experiments will be of interest.

In the Haber process the gases are purified by catalysis and their combination is effected by catalysis. In another step which is on the verge of commercial application, the same ammonia is oxidized to nitric acid by catalysis. In view of these and a dozen other recent applications of the same phenomenon, we can but wonder how much more catalysis may do for us in the future. Certainly such research work appears unlimited in potential value.

Pig-Iron**Production in 1921**

ON ACCOUNT of the physical disabilities of the iron industry in 1917, 1918 and 1920 we have the curious statistical fact that there has just been the longest interval in 43 years without a new record being made in a year's production of pig iron. The official report just issued shows a production in 1921 of 16,688,126 gross tons, last year having added a fifth to the years that have failed to break the record made in 1916, 39,434,797 tons. Not since the period 1874 to 1878 inclusive has there been a 5-year interval without a new record. Otherwise the comparison fails entirely, for after 1873, which was a panic year despite its record pig-iron production, there was practically no new construction for several years, while after 1916 there was new construction, the capacity not being available when iron was particularly wanted, in 1917, 1918 and 1920, because the railroads could not move sufficient fuel. Another difference is that the last year of this latest 5-year period, 1921, was by far the poorest year of the five, while in 1878 the iron industry was getting ready to make a new record.

Pig-iron production, in gross tons, from 1870 to 1921, inclusive, has been as follows:

1870.....	1,665,179	1916.....	39,434,797
1880.....	3,835,191	1917.....	38,621,216
1890.....	9,202,703	1918.....	39,054,644
1900.....	13,789,242	1919.....	31,015,364
1910.....	27,303,567	1920.....	36,925,987
1915.....	29,916,213	1921.....	16,688,126

On the basis of the 1916 production, with allowance for increases in capacity, the present capacity may be estimated at fully 45,000,000 tons, so that production in 1921 was about 38 per cent of capacity. There is room for argument that if iron and steel had been less scarce in 1920 the production in 1921 would have been larger. Production had been subject to three curtailing influences, the iron and steel strike begun Sept. 22, 1919, the bituminous coal strike and an insufficiency of transportation. Prices of steel and of manufactures of steel were forced to extremely high levels. At the beginning of 1921 there were high-priced stocks and the ultimate consumer was discouraged. To cite a commodity, usually exceptional, to test the rule, there were large stocks of canned food and other products in tin plate containers, the liquidation of which was very slow, the result being that tin plate, which usually holds up well in poor times, had a phenomenally poor year in 1921.

The iron industry has been particularly hard hit by the smallness of demand because there is a much smaller percentage than ever before of obsolete or obsolescent equipment. As the blast furnace has been improved from time to time, it is natural that a smaller proportion of the existing capacity is behind the times than used to be the case. Production, moreover, has tended to center more in certain districts, where the producers are more or less on an equality. Not infrequently in the past there have been times when the percentage of relatively high-cost furnaces was so great that the low-cost furnaces could make profits even though the total demand was much under the full capacity, whereas even now, when the rate of production is about 30 per cent greater than the average rate in 1921, there are many furnaces idle whose equipment and location cannot be criticized.

The layman is sometimes confused in attempting to

harmonize the concept that steel is made from pig iron and some pig iron is used for making iron castings with the fact that in recent years our production of "steel" has exceeded the production of pig iron. Last year's production of steel ingots was about 19,500,000 tons, but in finishing the steel a loss of about 24 per cent occurs, to reach the material statistically reported as "finished rolled steel." The scrap involved, together with old material, is used in making steel, while for years the production of iron castings has been growing at a much slower pace than the production of steel.

Panic Prices**For Coal**

EVERY factor now indicates a strike of serious proportions in the coal mines on the first of April. It is highly improbable that the Secretary of Labor, the Secretary of Commerce or any other government official can find any means for preventing this, despite the commendable efforts being made to that end. However, the situation is not by any means as black as painted by many; and there is no cause whatsoever for panic prices for coal.

Official estimates indicated that on the first of January of this year there was in stock in the hands of consumers about 47,500,000 tons of bituminous coal, which represented for these consumers on the average approximately 6 to 7 weeks' supply. During January production continued at least slightly above the rate of current consumption, and during February it is estimated that coal flowed into storage in considerable quantities every week. This condition will doubtless continue with even marked increase during the current month; and the end of the coal year will be reached with a certainty of average stocks throughout the country amounting to nearly 2 months' supply of bituminous coal. This is an exceptional, but very fortunate, condition for the end of a coal year, since normally at the beginning of spring the bituminous coal stocks of the country are reduced to a low figure as a matter of ordinary operating routine.

Another important factor must be taken into account also. This is the fact that the maximum probable interruption of coal production in union mines from strikes is not at all likely to cut off as much as half of the total production. Not only are there always some mines and some workers in various mines who do not go on strike, but also there are large sections of the bituminous coal territory which are operated on a non-union basis. It has been estimated on the basis of official figures that the maximum effect of the coal strike in union fields will probably not lower the production below six million tons per week. This is practically enough coal to run the country during the summer season with sub-normal business conditions prevailing as they now do. Certainly if six million tons per week is produced regularly during a strike period, this with existing stocks would care for the entire industrial demand of the country for many months.

It is worth while bearing these facts in mind. There will be great temptation to rush into the market and purchase coal as soon as the usual sources of supply are in any way interfered with. But this is wholly unnecessary, especially if carried to the extent of paying panic prices for the fuel. If American industry will "keep its feet on the ground," there will be no excuse for a runaway market.

Readers' Views and Comments

When Does an Employment Contract Terminate?

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read your editorial on "When Does an Employment Contract Terminate?" in the Feb. 22 number of CHEMICAL & METALLURGICAL ENGINEERING with a great deal of interest. I also read the opinion of the Chicago attorney. I agree with you absolutely, that technical men should be protected from every danger of blacklist, boycott or attempted curtailment of their usefulness to themselves or society through the operation of contracts signed while seeking employment. I also heartily agree with your stand that a court precedent should establish that a contract terminated in one particular is thereby terminated in every other. It seems to me that this is a matter of vital interest at the present time and that you are doing a noble work to bring the matter to the attention of the readers of your magazine.

W. M. CORSE.

Monel Metal Products Corp.,
Bayonne, N. J.

To the Editor of Chemical & Metallurgical Engineering

SIR:—Your editorial, "When Does an Employment Contract Terminate?" has very greatly interested me. It is a subject that has so many angles to it and is so dependent on the indeterminate personal equation that I hesitate to commit myself on the matter within the space of an ordinary communication.

Employment contracts exist in great variety, each corporation acting on the initiative of some one of its officers and in many cases without the scrutiny of an attorney with wide experience in drawing this class of contract. It is therefore impossible to discuss within a few words the broad general aspect of the individual contracts, for the real vital principle at stake varies so greatly in the form of statement, and language is here the key to the situation.

From the standpoint of *intent* I am quite certain that all reputable corporations have in mind the desire to prevent traffic in confidential information in their possession. Many such acquisitions have been purchased at considerable cost, and the purchaser is frequently obligated by contract not to convey the same to others. In other cases the specific information has been acquired by research and development at great cost, and the obligations of the executives to the stockholders require the guarding of the latter's interests. It is entirely fair and just to base a contract on such property and to place a restriction clause in an employment contract covering such property rights and their disposition.

Assuming the right of property in such matters, our problem becomes one of a fair disposition of the same. The fundamentals of all contracts are good faith and equity. Good faith in dealings between the corporation and the employee implies a detailed presentation of the character of the service to be rendered. This should be covered in great detail, and frequently be supplemented by additional contracts if necessary.

In the next instance, the contract should specifically provide for service as such, and in addition and separate from the first, restrictions on the disposition of discov-

eries, inventions, confidential information and future traffic in the latter items. The service clause should be for a definite period of time, a month, a year, or longer. Provision should be made for its termination because of unsatisfactory service after due notice, otherwise if the whole burden incident to unsatisfactory service rests on the employer, employment will become too difficult in general. General business depression should not be a terminating factor, any more than it is on raw material contracts. The weakness lies in the machinery to adjust such differences as might arise in connection with the service clause, this at present being more burdensome to the employee than to the employer.

The restrictive clauses are more complicated. Real property is conveyed with restrictions as to its use. These restrictions are limited as to expiration date; in the case of patented articles to the date of expiration of the patents. The restrictive clause in the employment contract should similarly be limited as to expiration. Now it is pretty well recognized that chemical processes, for example, become obsolete in a comparatively few years. I believe that so-called secret processes rarely persist in their original form for 5 years. The equitable form of contract would therefore terminate the restrictive clause in a reasonable and comparatively short time. This period has nothing to do with the period of service, and their termination would not be simultaneous.

The restrictive clauses should be explicit to be fair. I am not in sympathy with the attempts frequently made to broaden the scope of such clauses to cover everything. No attempt should be made to cover any more than the specific activities directly concerned. Provision should be made for supplementary contracts if necessary to cover advances in the state of the art. With good faith shown in the incorporation of such clauses in the contract, there can arise no criticism on the part of the employee, for no individual meriting at any time such confidence as to become a party to such contract can be so narrow in his adaptability as not to find means of livelihood outside the narrow restricted field intended to be covered. I should even very closely scrutinize a plea of hardship.

I therefore believe that a perfectly fair employment contract can be drawn which will protect the employer in his just intent as discussed above, and future criticism on the part of the employee forces on the latter the burden of proof that he signed such in good faith. Compensation under such contracts is generally above the normal for the same class of general service, and the extra compensation must be looked upon as a surplus against the imposed restricted future activities.

The real remedy for abuses, if such exist, is to make unnecessary this form of contract. This can be done by eliminating the necessity of maintaining processes secret, through a comprehensive and adequate patent law whereby the granting of a patent assumes novelty, without the burden of adjudicating the same through endless litigation.

Raising of the ethics of the profession would go a

long way, for I believe that if all members of the chemical profession are governed by the highest motives of loyalty and fair dealing, there will be no misunderstanding concerning employment contracts on the part of either the employer or the employee.

These two remedies are such remote possibilities that a more practicable method of immediate application would be to have our major engineering societies take up the matter of a uniform employment contract, providing such has not already been done, and under the guidance of proper legal assistance and with the co-operation of representative employers in as many fields of activities as is practicable, I am certain an equitable form of contract could be drawn.

W. S. LANDIS.

New York City.

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with interest your editorial in the Feb. 22 issue of CHEMICAL & METALLURGICAL ENGINEERING, also the comment as formulated by Wellington Gustin.

It has always appeared to me that arrangements made between technical men and financial interests have been too vague and often leave a confusing impression. A contract drawn up between a chemical engineer and his employer should never include terms which forbid for all time the technical man in question carrying out other lines of work of similar nature, should the company find it necessary to discontinue his services. No man should agree to limit his value on this earth by any such arrangement.

I am firmly convinced, however, that the manufacturer should have adequate protection, having in mind particularly an extremely small percentage of technical men who purposely might seek employment in a certain industry for purely dishonorable purposes. I think it entirely just and legal that a contract include terms which for a reasonable time prohibit the technical investigator either publishing or applying for patents on subjects which are directly concerned with work within the industry.

In other words, I think there should be established a reasonable time interval during which the manufacturer may protect his own interests by suitable patent publications. This could usually be done within a period of not greater than 2 years. It is also fair to assume that a technical man in a responsible position will disclose important information to his employer and agree to apply for patents and assign such patents to the company in question. Such an agreement could also appear in the contract terms. I believe that arrangements of this type would encourage disclosures of progress through patent publication, and would discourage the accumulation of a rather large amount of technical information which is now zealously guarded by so-called secret processes.

A reasonable time limit within which the technical investigator would be committed to public inactivity so far as the particular work in question is concerned would surely offer adequate protection in most cases which might arise. It would also provide an opportunity for the investigator to continue work along lines in which he may have become interested and which may result in findings of extreme importance. In all events, special cases would always be open to litigation and could be judged according to precedent and equity.

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GEORGE A. RICHTER.

To the Editor of Chemical & Metallurgical Engineering

SIR:—In regard to the editorial, "When Does an Employment Contract Terminate?" and also the comment of Wellington Gustin under the same title, the following may put into bas-relief certain phases of the subject under discussion which have been so well covered by those articles.

The employer is almost the exact antithesis of the employee and his functions are almost exact antitheses of the functions of the employee. The differences may be summed up tersely as follows:

The employer deals with humanity, while the employee deals with scientific knowledge, ingenuity and materials. It is the employer's business to accomplish as much as he can by utilizing humanity, and his success is measured by the ability which he displays in utilizing humanity. In the same way the employee's success depends on the use he makes of his scientific knowledge, ingenuity and materials.

Now, while the employer delves into the storehouse of knowledge and materials held by the employee, the employee has not as a rule thought it necessary to delve into that knowledge of human nature upon which in a large degree business depends. And right here is where the employee loses out. It thus happens that the employer is in a position to work upon the credulity of the employee who has not taken the trouble to inform himself of his rights and privileges. The courts have many times decided that the employer who furnishes materials and defrays all expenses of fruitful research thereby acquires a shop right in the invention, but that the inventor is entitled to the patent rights unless otherwise assigned. On the other hand, if the inventor makes his invention at his own expense and in his own time, the employer has no claim on even a shop right in such an invention. This knowledge is known by the employer, but is not usually known in time by the employee if known at all. The employer uses such knowledge as this to insert into the contract of employment that the employee shall assign all inventions during his period of employment to his employer. In a sense this is coercion, for a man in face of present necessities will sign away any rights for the future which he regards as fanciful, illusive or only existent in the fancies of his employer.

The employee furthermore does not as a rule take advantage of such business opportunities as are open to him. He not only does not do this, but he deliberately puts his neck in a noose and then complains if the holder of the noose is tempted to pull it tighter than he thinks comfortable.

The business man has no hesitation in advertising his goods and stock in trade. He is not held back by any false modesty from claiming that he and he alone is giving more value to his customer than any one else. This is so much the custom that such action is regarded as a matter of course.

The employee may be a shining light and yet may have it hidden within the walls of a factory so that others have no knowledge that such a light exists. You certainly cannot blame an employer having a gold mine for not advertising it when such advertisement might result in the payment of increased royalty or might lose for him the gold mine altogether.

Now having shown that the employer has no object in advertising his employee, it necessarily follows that the employee will remain unadvertised unless he is

advertised by one who will benefit by such advertisement and that one is himself and no other.

The employee's ability, knowledge and accomplishments are his stock in trade, and it is up to him to create a demand for his wares. While modesty is an admirable quality in polite circles, it has no place in business, especially that false modesty which enforces a sort of peonage on the employee. The law of supply and demand is as applicable to labor as to materials and the employee should know this and create a demand for his services by some sort of advertisement. When there is a large demand for his services, then the employee will receive compensation commensurate to his worth and the demand.

Nor is there a lack of opportunities for judicious and dignified advertising. The technical journals are open to a man who has something worth while to say and the technical societies are anxious to obtain the co-operation of a man of sound ideas who has back of him the record of accomplishment. By this I do not mean that the employee should divulge any of his employer's secrets while in his employ, for there is no justification whatsoever of such a proceeding. But the employee obtains a vast amount of knowledge which may be correlated in new ways, giving valuable scientific results. These usually are his own property and part of his stock in trade. These things he can use himself or give to someone else to use for him in acquiring the sought-for reputation.

While the obligations of the employee to the employer are easily defined, the obligations of this same man to his former employer when he is no longer the employee are scarcely definable at all, inasmuch as these are governed almost entirely by the original contracts and by the ethics of the particular case.

Contract or no contract, the employee owes complete loyalty to his employer. Mutual confidence, trust and respect are the foundation stones for both parties.

I believe that applies in the great majority of cases and I do not believe that more than 1 or 2 per cent of a scientific staff deliberately obtain employment for the purpose of obtaining secrets.

Now having touched on the above principles, let us get a little closer to the subject in question.

In making a contract the employer has a right to safeguard his existing property, including secret processes, if he can. The only protection he has, however, is so to adjust conditions that the employee has a mutual interest in the secret. He can bring suit for money damage against the employee, but this right is weakened by lack of money responsibility of the employee. In case of enticement he can bring suit against the offending corporation, but enticement would be difficult to prove in cases where the employer let his staff go whether because of business depression or some other reason. In exercising his right of discharge, he made a choice in which he presumably considered the problem of dissipation of the firm's stock of knowledge and his chances before the law court. In exercising his right of discharge, self-interest will compel him to act in such a manner that the firm shall suffer the least and the axe will fall upon him who can least easily obtain a job in a competing concern. And this is the man who neglected to make hay while the sun was shining.

The reason is obvious, for the man with a wide reputation can in a consulting capacity disseminate this knowledge far and wide, thus making competition keener, with the result that it will be cheaper to keep

him on the payroll, even if there is nothing for him to do, than cast him adrift where he can do untold harm. On the contrary, the man of a retiring disposition is scarcely to be feared, for he has already shown that he has the lack of business initiative and such initiative cannot be developed on the spur of the moment. In an equity case the complainant must come into court with clean hands. The issues could be thoroughly befogged in an equity court. Not only would this be the case, but the facts concerning the secret process would have to be divulged, in which case the process is no longer secret and the appeal to equity has defeated its own purpose.

It seems to be a fact that employment contracts really have but little value for the employing party unless made with persons having moral responsibility, because the financial responsibility usually isn't there.

There is one phase of this question which should be carefully considered. Is it consistent with public policy that a man should be required to sign away the patent rights of something which he has not yet invented and knows not the value? Should not the employer be forbidden by law to insert such a clause into any contract with any employee? As it is, this is a sort of coercion or peonage in that the employer will always give the job to him who thus signs away his rights, not knowing their value. Is it not consistent with public policy that such insertions of a coercive nature be declared null and void? When such an invention has been made, the employer will usually have a shop right and will have the advantage of knowing its full value better than any outsider. He can then make terms with the inventor and such terms being made in light of full knowledge will have more of the elements of justice.

Another phase of this matter seems at least worthy of mention. When an employer hires the employee in such a capacity where it is known that he will obtain secrets and in all probability make valuable discoveries and where the employer assumes the financial burden of all the experimental work, the employer has certainly some rights. It is scarcely just to expect him to stand the financial losses indissolubly connected with those experiments which turn out failures, while the employee reaps all the benefits of those experiments which turn out to be successes. Such a condition would be against public policy, as it would mean the end of research and consequently tend to check progress.

I am inclined to agree with the general position of the editorial that it would be against public interest to make enforceable a contract binding a man not to use previously acquired knowledge or training.

The operator of a secret process has always been presumed to know that he has a perishable article and that the risks are all his own; the patent law itself is a recognition of this.

And, finally, we must not lose sight of the fundamental truth which has governed and always will govern the actions of humanity. In the final working out of the economic law irrespective of what laws are now on or may be put on the statute book, self-interest is the all-controlling factor. Where initiative, foresightedness, energy, prudence and due attention to self-interest will bring their reward, the lack of them will as certainly bring embarrassment and want in time of stress.

The ultimate solution depends upon the employee's ability to make it contrary to the self-interest of the employer to discharge him.

HUGH K. MOORE.

Brown Co., Berlin, N. H.

British Chemical Industries

FROM OUR LONDON CORRESPONDENT

LONDON, Feb. 17, 1922.

THE trend of business in January and particularly in the first two months of the year is usually a reliable index to the ensuing year's prospects, and on the whole the outlook is considered favorable. The annual reports and the speeches of the chairmen of the great banking groups have, it is thought, summed up the position with exceptional lucidity and in accordance with informed public opinion. Briefly, strict economy and thrift are to be the watchwords for all, with a definite hope of improving trade and stability, particularly on export account. The reduced bank rate and some relief in the pressure of continental competition, together with easier monetary conditions, have already made themselves felt and stocks in many commodities are appreciably lighter. Buyers in consequence are becoming uneasy and covering their requirements over a longer period instead of continuing the hand-to-mouth policy which served them so well during the recent period of uncertainty and stringency. It is still too early to say anything definite as to the effect of recent legislation, but the safeguarding of industries act has certainly stimulated the fine chemical trade and saved it from complete stagnation. The sulphuric acid and fertilizer trades are reviving, sulphate of ammonia being in demand owing to the peculiar conditions prevailing in America, and basic slag being also in good inquiry. Failures in delivery from continental sources have caused prices to harden in several cases and with a miniature revival in the coal, steel and textile trades, the prospects are distinctly encouraging.

GAS COMPANIES DEFEND THE USE OF WATER GAS

The scare raised in the daily press in connection with the presence of carbon monoxide in coal gas due to the admixture of water gas has roused widespread interest and comment. It so happens that a few cases of carbon monoxide poisoning due to escapes of gas occurred in the provinces and attention was promptly called to the large number of parallel cases which were noted at one time in the United States. The agitation has now practically died down, but not before an order was made under the gas regulation act regulating the amount of carbon monoxide which may be supplied in domestic gas unless the gas supplied has the distinctive odor of coal gas. The chairmen of the two leading gas supply undertakings in London defended the use of water gas, although the South Metropolitan Gas Co. has not so far used it as a diluent.

CALCIUM CARBIDE HELD TO BE AN INORGANIC CHEMICAL

The result of this case was almost a foregone conclusion, but the hearing under the safeguarding of industries act was useful in clearing the ground for other cases. The referee in his decision stated that he would adopt the principle that no article should be included in the dutiable list if there is any reasonable doubt that it should be excluded, and that the burden of proof is on the complainants; that in regard to "fine chemicals" he would adopt the rule: Has it been proved that in the opinion of the bulk of chemists this or that is a fine chemical? But he would accept this only if there was a technical definition. What happened in the carbide case was that an equal number of

eminent experts on either side were willing to classify calcium carbide as organic or inorganic, but the balance of evidence from textbooks and official publications inclined to its classification as an inorganic chemical.

CONFLICTING EVIDENCE IN THE CREAM OF TARTAR AND TARTARIC ACID CASE

This case, in which citric acid is also included, will turn on the point whether the term "fine chemical" has a well-understood commercial meaning and if so, what is the accepted view of the trade. The result so far has been a plethora of definitions in the technical press, not one of which has yet been applicable to every instance that can be cited. We have here products which can be obtained in commercial quantities with a high degree of purity both by skilled and by unskilled methods of manufacture according to the locality in which such manufacture is carried on. French firms appear to be manufacturing crude products without skilled supervision and control, while in this country, which draws its raw material from a number of sources, scientific control is essential, especially for the manufacture of B. P. products. The process as carried out in France would, according to one definition, enable the product to be classified as a heavy chemical, whereas in this country tartaric acid would, under the same definition, be a fine chemical. The view of the trade seems to be that, except for B. P. products, the large quantities sold and trade usage will enable the crude products to be imported free of duty, while discriminating against B. P. products.

ALBY CARBIDE CO. GOES INTO LIQUIDATION

This company has been in difficulties for some time, mainly on account of the unfavorable contracts into which it had entered and owing to its failure to pay for its power rent, the plant having closed down. The Tyssefaldene Power Co., in which the Barton group holds a controlling interest, has bought the whole plant, valued at about \$1,500,000, for about \$7,000, the rights held by the power company rendering it impossible for others to bid at the foreclosure sale. In consequence, Alby shares are now valueless and the company will be wound up. The recent carbide decision lends additional interest to the case, but as regards the future operations of Cumberland Coal, Power & Chemicals, Ltd., in Norway, the position is still very uncertain, as so far the capital required for the development of the Claude process does not appear to have been forthcoming. Mr. Barton was originally closely connected with the Alby Carbide Co.

GENERAL NOTES

The British Dyestuffs Corporation has failed to pay a dividend on its preference shares and although markets are improving, the future does not seem to be very bright. This also applies to the British Cellulose Co., whose shares have fallen still further, partly on account of the decisions in the carbide case. An interesting monograph on synthetic phenol manufacture during the war has been published by the Department of Scientific and Industrial Research, and is worth studying for its chemical engineering interest alone. Further progress is being made in the standardization of chemical plant, both by the British Engineering Standards Association and by the Association of British Chemical Plant Manufacturers, the latter having made a beginning by publishing designs for standard jacketed pans.

American Ceramic Society, Annual Meeting

Report of Twenty-Fourth Annual Meeting, Held at St. Louis—Important Papers Presented Before the Meetings of the Seven Industrial Divisions: Art, Enamels, Glass, Heavy Clay Products, Refractories, Terra Cotta, White Wares

IT was scarcely necessary for Mayor Kiehl of St. Louis to utter formal words of welcome to the members of the American Ceramic Society, gathered at the Hotel Statler for their twenty-fourth annual meeting, Feb. 27 to March 3. The almost continuous rows of brick structures throughout the city evidenced appreciation of what ceramic skill has done to advance human comfort and happiness. Then, too, the sight of the great refractories plants, the fireclay mines even within the city limits and the knowledge that the whole city rested on clay deposits—what more was needed by way of welcome! Nevertheless Mayor Kiehl was there in person to extend a hearty greeting.

Throughout the meeting a state of constant, yet ordered, activity was maintained through the untiring efforts of the local committee. The complete absence of friction in carrying out the schedule indicated careful preparation. The smoker and entertainment on Monday, the informal banquet the following evening and the plant visits on Thursday and Friday were potent factors in maintaining that spirit of fellowship for which the Society is noted.

Through the efforts of the Art Division an exhibition of ceramic wares was held in conjunction with the meeting. The exhibits covered the entire range of ceramic products—from the highly artistic and beautiful work of Mr. and Mrs. Rhead, Prof. Binns, Miss Farren and others to the more commonplace sanitary ware, chemical stoneware, electrical porcelain, refractories, etc.

General Sessions

Forrest K. Pence's presidential address on "Progress and Policy" brought out the necessity for outlining a general policy for the Society in its enlarged field, in order to render the most service possible, both within and outside of the organization. As examples of service needed, Mr. Pence mentioned the publication of a ceramic handbook and monographs on certain industries.

Conditions have changed since the Society was founded and a stage has been reached where the industries are beginning to see the economic reason for co-operative research. The industries must finance this group research, but it is the function of the Society to encourage such work and to provide a publication medium and a forum for discussion.

REDUCTION OF VARIETIES

E. W. McCullough, manager of the Fabricated Production Department, Chamber of Commerce of the U. S. A., outlined the work which is being done to eliminate excess varieties of commodities. For machine-made products, small variety and large output are essential to low cost. In many lines, our salvation has been and will continue to be mass production, but mass production is not possible if varieties are multiplied to meet the whims of overambitious sales organizations. An example was given of an iron and steel firm which discovered that its catalog was increasing out of all proportion to the

profits. Upon studying the 17,000 products listed, it was found that only 614 were profitable.

Prof. C. W. Parmelee proposed a new classification of clays. Prof. E. W. Washburn and Elmer N. Bunting demonstrated and explained their porosimeter for determining porosity by the method of gas expansion. Deformation studies of the silicates and aluminates of the alkali metals were reported by B. A. Rice. Investigation of the systems $K_2O-Al_2O_3-SiO_2$ and $Na_2O-Al_2O_3-SiO_2$ indicates that sodium and potassium may be interchanged for their fluxing value.

From X-ray spectra, Prof. E. W. Washburn and Louis Navias conclude that raw chalcedony and raw flint have the structure of quartz, while after calcining the structure of both resembles cristobalite. Both are probably colloidal.

Dr. Kurd H. Endell, professor of ceramic engineering at Charlottenburg, extended an invitation to the members to meet with the newly organized German ceramic society in June.

In a paper on "Reduction of Industrial Wastes," Dwight T. Farnham reviewed the important work done along these lines.

FUEL OIL SYSTEMS

Important factors to be considered in installing and operating fuel oil systems were discussed by James D. Lalor. He recommended that storage tanks be placed in concrete pits rather than buried directly in the earth, since a leak in the latter case might cause serious trouble before it was detected.

R. M. Howe showed that the furnace gas pressure has a very decided effect upon heat transmission through furnace walls. A 10½-in. tile was set in the door of a surface combustion furnace and temperatures were measured in this tile 1, 2, 3 and 4 in. back from the hot side. Under a draft of -0.30 in. of water the temperature drop across the 4 in. was from 1,340 to 500 deg. C. With a draft of +0.05 in. the drop was 1,340 to 750 deg. C.; with forced draft (+1.00 in.) from 1,340 to 850 deg. C. Evidently the penetration of hot gases is a factor which must be considered.

ELECTION OF OFFICERS

Officers elected were: President, F. H. Riddle; vice-president, Dr. E. Ward Tillotson; secretary, Ross C. Purdy; treasurer, R. K. Hursh.

Mr. Riddle is director of research for the Champion Porcelain Co., Detroit, Mich. This was formerly the Jeffery-Dewitt Co., but is now a subsidiary of the Champion Spark Plug Co. During the war Mr. Riddle was associated with A. V. Bleining at the Bureau of Standards and worked on the development of special high-temperature porcelains, including spark plugs for airplanes, also on the development of the casting of porcelain glass pots for optical glass manufacture.

It was decided to transfer all editorial work to the secretary's office and to make the secretary editor of the



F. H. RIDDLE
President, American Ceramic Society.

journal for the coming year. Pittsburgh was chosen for the twenty-fifth annual meeting in 1923. The summer meeting this year will be held in Montreal and vicinity.

Refractories Division FIRECLAY DEPOSITS

Merely as a matter of record Paul E. Cox presented his paper confirming previous reports on the non-existence of satisfactory fireclay deposits in Iowa. There were some, however, which he thought might serve for cheap brick for the crowns of kilns. Prof. C. W. Parmelee then described in some detail the more important deposits of fireclays in Illinois.

INFLUENCE OF GRIND AND FIRING TEMPERATURE ON PROPERTIES OF SILICA BRICK

Some very interesting tables showing the influence of grind and of firing temperature on the properties of silica brick were presented by R. M. Howe. The time of grind was 10, 15 and 20 minutes and the firing temperatures from cone 11 to cone 19. The property studied in one set of tables was the modulus of rupture. In the 10-minute grind the modulus of rupture varied from 295 to 531 when the burn varied from cone 11 to 19, the average of 42 determinations being 440. Corresponding figures for the other grinds are 15 minutes, 285-618, average 446; 20 minutes, 330-694, average, 499. Averages of twenty-one determinations on the effect of temperature are:

Cone	11	14-15	15-16	17	18	19
Modulus of rupture....	303	368	444	572	533	614

Thus it will be seen that, judged from the averages, the firing temperature has a greater influence on the modulus of rupture than the time of grind.

The specific gravity was found to decrease from 2.50 to 2.30 in going from cone 11 to cone 19, while the grind did not have much effect on this property. Porosity increased slightly with time of grind.

HYDRATES OF ALUMINA

Studies of the composition and properties of diaspor, bauxite and gibbsite have led R. M. Howe and R. F. Ferguson to the conclusion that diaspor is the monohydrate of alumina, gibbsite the trihydrate and that bauxite is a mixture of the two. In the discussion which followed I. A. Krusen referred to the plant of the American Bauxite Co. at Bauxite, Ark. Here the bauxite occurs in blankets from 3 to 25 ft. thick and the stripping required varies from 10 to 60 ft. The overburden is removed by steam shovels. Most deposits are less than 10 acres in extent. The ore is crushed to 1-1½ in. in gyratory crushers and transferred to bins which feed ten rotary kilns, formerly fired with natural gas but now using powdered coal. The capacity is 2,500 tons a day, most of it going to the Aluminum Co. of America, although some is shipped to the Norton Co. At one time the General Chemical Co. took a great deal of low-grade ore for the manufacture of alum.

TESTING OF SILICA BRICK

Prof. K. Endell described briefly the methods used in Germany for testing silica brick.

An attempt was made by E. N. McGee to develop a relationship between the hot and cold modulus of rupture for silica brick, with the idea that the valuable indications given by the hot modulus might be calculated from the more easily determined cold modulus. Before any definite conclusion can be reached it will be necessary to test other brands and use more samples. The point at which the silica brick is weakest should also be determined.

LADLE BRICK

In a paper on ladle brick, D. A. Moulton stated that in this country this variety of brick is made from No. 1 and No. 2 fireclay and contains: SiO_2 , 60-67 per cent; Al_2O_3 , 20-24 per cent; Fe_2O_3 , 1-3.5 per cent; CaO less than 0.3 per cent; Na_2O and K_2O , 3.5 per cent. The brick are made either by the stiff mud or dry press process, the latter giving a superior product. The brick will usually withstand eleven or twelve heats. Special testing methods are required, as the tentative and standard methods are not applicable.

In discussion, A. F. Greaves-Walker, chairman of the division, emphasized the importance of ladle brick. They are used not only in the large copper and steel plants, but even in medium-sized foundries, especially where electric furnaces are used. He also referred to the secrecy which has surrounded the manufacture of ladle brick.

HEAT CONDUCTIVITY DATA

Data on heat conductivity of the different commercial refractories are somewhat confusing owing to the fact that the conditions of preparation or test are not comparable with industrial conditions. In presenting this subject, Prof. Arthur S. Watts emphasized the difference between heat conductivity as usually measured and heat transfer, which is what is really required for engineering work. The former neglects the skin or surface effect, which has a very appreciable influence on the rate of heat transfer from a point just in contact with

one surface to a similar point on the other side of the refractory.

Prof. Watts found that the literature on the subject was practically limited to the following: Wologdine and Queneau, *Electrochemical & Metallurgical Industry*, September and October, 1909; "The Thermal Conductivity of Refractory Materials," by G. Dougill, H. J. Hodsman and J. W. Cobb, *J. Soc. Chem. Ind.*, vol. 34, p. 465, May 15, 1915; "Thermal Conductivity of Refractory Brick," W. Van Rinsum, *Science Abstracts*, "B," Jan. 30, 1920, p. 18, also *Chemical Abstracts*, vol. 14, p. 1420, May 10, 1920. The scarcity of data and the fact that some of the available data are open to criticism prompted Prof. Watts to make an investigation to determine relative values, at least, under the following conditions:

(a) The test specimens are normal samples of commercial ware on which the burning temperature is known.

(b) The test specimens are of the same thickness so far as possible. All are exactly as made and burned except the magnesite brick, which was tested in the original thickness and later cut down by grinding off one face, thus reducing it to the same thickness as the others.

(c) The test furnace is an electrically heated furnace capable of maintaining an approximately constant temperature for a period of 8 to 10 hours.

(d) Each test is continued until a state of practical equilibrium exists. To insure this, the test was continued until the temperature change on either side of the test specimen did not exceed 5 deg. per hour.

(e) The conditions of test were maintained constant as regards drafts, the furnace being so located that the exposed face of the test specimen is cooled only by normal radiation.

(f) The same insulating arrangement is provided for all specimens. This consists of kieselguhr cleats cut to fit and extending $\frac{1}{2}$ in. over the edges of the brick, thus preventing radiation of heat along the line of contact between the furnace and the test specimen.

(g) Standardized copper-constantan thermocouples are used and the voltage measurements determined by means of a Leeds & Northrup potentiometer.

In order to make the results comparable, temperature gradients were determined by subtracting the temperature of the cold side of the test specimen from that on the hot side and dividing by the diameter of the test specimen expressed in centimeters. Hard steel was chosen as unity, giving the following results:

Specimen	Diameter, Cm.	Temperature Gradient, Deg. C.	Relative Transfer of Heat
Normal fireclay	3.1	174	0.448
High SiO ₂ fireclay	3.1	170	0.459
Bauxite	3.1	163	0.478
Sillia	3.3	152	0.513
Magnesia	4.0	125	0.624
Magnesia	3.1	135	0.578
Chromium	3.15	108	0.722
Hard steel	3.0	78	1.000

The above values are merely relative and must be so considered. The wisdom of using steel as unity is open to question, since its absorption and emission properties are widely different from those of the refractories. The relative heat conductivity may or may not be proportional to the temperature gradient of the different refractories. If it is proportional, then the relative values of the refractories as heat insulators would be:

Fireclay refractory	1.00
High-silica clay refractory	0.974
Bauxite refractory	0.937
Sillia refractory	0.873
Magnesia refractory	0.776
Chromium refractory	0.621



DR. E. WARD TILLOTSON
Vice-President, American Ceramic Society

It was pointed out by the speaker that the mean temperature throughout these determinations was only about 600 deg. C., which is below operating conditions for these refractories, and that consequently the work should be extended to higher temperatures.

In discussion, Mr. Greaves-Walker said that results such as these were of the greatest importance at the present time. With powdered coal, oil and gas, using air under pressure, temperatures of 2,800 to 3,100 deg. C. are becoming quite common. In order to maintain these temperatures with refractories now in use the walls must be made more conductive. Thus reverberatory walls which used to be 24 in. thick have been reduced to 9-12 in. in order to get rid of the heat. It is inefficient so far as heat goes, but the desired reaction is obtained without sacrificing the refractories. The same is true of high-powered boilers when forced much above their normal rating.

DISCUSSION OF QUESTIONS

Perhaps the most valuable part of this meeting was the discussion of a number of questions which had been asked by members and printed in the program so as to give time for consideration.

The problem of calcining clay was considered from many angles, including the relative merits of rotary kilns, downdraft kilns and other types. A. B. Christopher outlined the method used by the Evens & Howard Firebrick Co. The clay is fed from boxcars on a trestle directly into a shaft kiln having a capacity of three boxcars. The clay must be in chunks and not frozen. The kiln is 28-30 ft. high and 14 ft. diameter, with six fireboxes. To burn 140 to 150 tons of coal to a red heat requires under the most favorable conditions

18 tons of coal, although this may occasionally run up to 50 tons.

Silica, magnesite and chromium brick manufacturers are interested in the use of railroad tunnel kilns. Philip Dressler described a new type of tunnel kiln which has been designed to meet the requirements. Silica brick requires a long time to burn, so that in order to get capacity the cross-section of the kiln must be large. Then, however, it is difficult to control the flow of gas uniformly, as most of it tends to follow the crown. This led to the suggestion of passing the gases across the kiln instead of lengthwise and a kiln has been designed having 12-ft. sections each equipped with regenerators. Two tracks will be used, the cars passing in opposite directions to give efficient heat exchange. Prof. Endell remarked that a kiln using the principle was started 2 months ago in Germany for burning insulators to cone 16.

The possibility of machine-made silica brick also received considerable attention. It was brought out that some time ago the silica brick manufacturers got together in the Refractories Machinery Corporation and in conjunction with Prof. Norton of M.I.T. built and installed two silica brick machines. Only one actually worked and that gave no end of trouble, particularly in getting the brick out of the mold. The machine was finally scrapped. Another is being designed, however, which more nearly reproduces the operations of hand-molding and promises to be more successful.

Dr. F. A. Harvey called attention to the fact that while there were curves showing the thermal expansion and transition points for pure silica, there was none which could be applied directly to green silica brick being burned.

Glass Division

SUBSTITUTES FOR NATURAL GAS

Under the title "The Passing of King Methane," S. R. Scholes discussed the situation brought about by the rapid diminution in the supply of natural gas, which is conceded to be the ideal fuel for glass manufacture. The question of substitute was taken up, producer gas, byproduct coke-oven gas, and fuel oil being considered.

Mr. Scholes also deplored the lack of sufficient data on design in tank construction, and this point was brought up in the discussion which followed by H. L. Dickson, who pointed out that this condition was quite natural, since it is only recently that technical men have been employed in glass works. Full credit should be given the technical men for perhaps the major portion of the advances in tank construction.

ZIRCONIUM SILICATE BRICK IN SMALL GLASS TANK

H. T. Bellamy discussed the use of zirconium silicate brick in the crown of a small glass tank with surface combustion burners, in which a silica crown had eroded and spalled due to frequent shut-downs. Zirconium silicate gave none of these troubles. This is probably the first use in a glass tank of this new material, which, although twice as heavy as silica, and costly, has interesting possibilities.

OFFICERS

Officers for the division were elected as follows: Chairman, Dr. J. C. Hostetter; vice-chairman, A. R. Payne; secretary, A. E. Williams; councilors, Dr. H. W. Hess and J. W. Wright.

Enamels Division

The meeting of the Enamels Division opened with a paper by L. A. Adams describing a brushing and stripping machine, which eliminates the use of hand brushing in wiping the edges of stove parts and similar pieces.

W. C. Lindemann discussed the use of the Mott sand table, and J. F. Bardush gave the results of some experimental work on the adaptation of the Meurer apparatus for spraying and applying melted enamel.

ELECTRIC FURNACES FOR ENAMELS

Studies designed to determine whether the reducing conditions in a carbon resistance furnace would be detrimental to enamel smelted in a furnace of this type were outlined by E. E. Geisinger. The results obtained were satisfactory, although no marked improvement was noted.

Recent installations of electric furnaces in bathtub, kitchen ware, sign and watch dial enameling plants were described by James Carpenter.

AIR-COOLED ENAMELS

Stefan Wiester gave the general results of studies on the use of enamels chilled from the smelter by compressed air instead of being water-quenched. An interesting feature of this work is the appearance of the enamel. Due to the fine division of the glass, it is fluffy and light, and looks like a mass of cotton.

EFFECT OF FINENESS OF GRIND ON OPACITY OF WHITE ENAMELS

Finding it difficult to obtain uniform opacity in two-coat kitchen ware having one ground coat and one white coat, B. T. Sweely and E. S. Prince investigated the influence of the fineness of grind on opacity and found this factor to be a most important one, since opacity is a refraction phenomenon. It was not found possible to control the fineness by the time of milling, since the latter is influenced by the amount of moisture in the mill charge.

Mr. Sweely also read a paper on "Relation of Composition and Resistance to Thermal Shock," in which he called attention to the fact that during sudden temperature changes the outer coat of an enamel may respond before the change has been transmitted to the inner coat. Increasing the coefficient of expansion of the ground coat was suggested so that ground and cover would expand and contract more nearly at the same rate.

OBSERVATIONS ON FISH-SCALING OF GROUND COAT

Interesting observations on fish-scaling of ground coat enamels were made by B. T. Sweely. Various articles enameled on both sides were treated with an acid so that the enamel was entirely removed from one side. According to the author, this should throw compressive strain into the enamel on the other side. If fish-scaling is due to compressive strains in the enamel due to difference in the coefficients of expansion of the enamel and steel, fish-scaling should result in the cases under observation. This was definitely shown in a number of specimens which had not previously shown fish-scaling, although they had been in stock for a number of months prior to the test. Furthermore, ware coated with an enamel apparently in tension (since crazing occurred) did not show fish-scaling when submitted to the acid treatment. In discussion, it was

brought out that other investigators had produced fish-scaling in pieces coated on only one side upon treatment of the other with acid. It would seem that penetration of the ware by hydrogen or even acid might be as important in this case as the release of compressive strain.

MICROSCOPIC STUDIES OF ENAMEL REACTIONS

A microscopic study of ground coat and cover coat enamel reactions, by E. E. Geisinger, showed the effect of various enamel ingredients on the structure and also the effect of under-firing, over-firing and correct firing. Certain oxides showed evidence of reduction in that there was considerable bubbling in the enamel. In these cases the adherence was good. This apparently explains why cobalt oxide and other oxides are beneficial in ground coats. Mr. Geisinger illustrated his talk with a series of remarkable microphotographs of vertical cross-sections of enamels. In all cases the line of demarcation between the various layers was distinct.

WET PROCESS ENAMELS FOR CAST IRON

R. R. Danielson and H. P. Reinecker reported an extended investigation by the Bureau of Standards on wet process enamels for cast iron. The effect of various refractories as mill additions and the effect of variation in ground and cover coats were given. It was shown that large additions of flint, feldspar or clay to ground coats produced unsatisfactory enamels in that it resulted in poor adherence to the casting. It was found that comparatively large amounts of lead oxide in ground coats of this type were not detrimental. Excess boric acid caused crawling in both ground coat and cover enamel. Cryolite had a tendency to cause the same trouble in the cover enamel. Large amounts of Na_2O were detrimental in that pin-holing was increased considerably.

MODIFIED MOLECULAR FORMULA

The present molecular formula used by technical men for glaze and enamel calculations is capable of misinterpretation. J. E. Hansen suggested a modification which should relieve the situation and furnish a better basis for the comparison of enamel formulas. In this modified formula an attempt is made to show the mineralogical form in which the fluorides are introduced.

COMPOSITION OF CAST IRON FOR ENAMELING

M. E. Manson called attention to the fact that the physical condition of cast iron was more important than the chemical composition. Thus cast iron made from Northern pig tends to develop blistering in the enamel, while very satisfactory enameling results can be obtained on cast iron from Southern pig iron.

The committee on research has in mind the collection from cast-iron enamellers of representative samples of iron giving satisfactory and unsatisfactory results in enameling in order to make a systematic study of their physical and chemical properties in relation to enameling. This work will be under the direction of R. R. Danielson of the Bureau of Standards, Washington.

FISH-SCALING

The committee on research and development reported the results of co-operative work in the preparation of steels based upon the conclusions reached in the Bureau of Mines work on fish-scaling. Tests on about 2,000

sheets of steel prepared by the American Sheet & Tinplate Co. and enameled in three kitchenware plants were described. The sheets were cold-rolled to various extents and it was found that the tendency to fish-scale was reduced up to about four passes. Further passing did not prove beneficial. This apparently confirms the conclusions of the Bureau of Standards based upon laboratory work. The final report will be included with the bureau's work in a Technologic Paper on "Causes and Control of Fish-Scaling."

HEAT-RESISTING RACKS

Preliminary laboratory tests on various types of heat-resisting alloys for use in burning racks were discussed by E. P. Poste. Studies on warpage and oxidation of the various alloys as compared with the cast iron and steel now commonly used seem to indicate that some of the alloys may be preferable. However, definite conclusions could not be drawn at this time.

Enamel Division elections gave the following results: B. T. Sweely, chairman; R. R. Danielson was re-elected secretary; councilors, H. F. Staley, R. D. Landrum, W. C. Lindemann, D. F. Riess.

Terra Cotta Division

FIRE CRACKING

Fire cracking occurs in terra cotta under certain conditions and is characterized by the appearance of sharp, hairline cracks extending into the bodies.

Experiments were made by E. C. Hill on firing large typical pieces made from various clays and grogs and cooling at different rates. The tendency to fire cracking was observed after weathering. The rate of cooling was found to have a much greater effect on the tendency to fire crack than the composition or physical properties of the body. Sandy clays gave more trouble than non-sandy vitrifying clays. The kind of grog is much less important in this respect than the kind of clay.

SHIVERING OF TERRA COTTA GLAZES

Six terra cotta clays were tested for shivering as a body trouble by John L. Carruthers, using a white mat glaze, at cone 3 starting. One non-shivering clay and one badly shivering clay were experimented with to produce and overcome shivering.

Causes of Shivering. From this work and that of others which has been checked, the causes are:

- (1) Presence of finely divided silica in the body from
 - (a) highly siliceous clays,
 - (b) finely ground grog of a siliceous nature.
- (2) Presence of soluble salts in clay, grog or tempering water.
- (3) Longer firing periods.

Elimination of Shivering. The methods suggested were:

- (1) Use of a flux such as feldspar to overcome action of fine silica.
- (2) Use of coarse grog or sand.
- (3) Use of BaCO_3 to overcome effects of salts.

OTHER DIVISION MEETINGS

Interesting meetings were also held by the Art, Heavy Clay Products and White Wares Divisions, in which matters of importance to the members were discussed, but lack of space precludes a detailed account here.

Contributions to the Study of Ammonia Catalysts—I

The First of an Important Series of Articles From the Fixed Nitrogen Research Laboratory, With Introductory Note by Richard C. Tolman, Director—Description of Apparatus for the Small-Scale Testing of Ammonia Catalysts at Atmospheric Pressure

By A. T. LARSON, W. L. NEWTON AND W. HAWKINS

INTRODUCTORY NOTE

ONE of the most important lines of investigation of the Fixed Nitrogen Research Laboratory¹ has been a study of the synthesis of ammonia from nitrogen and hydrogen. The marked success achieved during the last few years in Germany in applying this reaction to large-scale nitrogen fixation, together with the important attempts which have been made in this country and in France, Italy and England to utilize the same reaction, has emphasized the need of a broadly conceived study of the entire subject.

The problem of economical large-scale ammonia synthesis is one of the most complex known to chemical industry. It is capable of attack from a great variety of angles, and successful solution is perhaps possible under a wide variety of conditions. Thus the method developed in Germany, largely as a war emergency, is certainly not ideal and may not represent in any way the most satisfactory ultimate solution. The Fixed Nitrogen Research Laboratory has therefore studied, and is studying, the problem of ammonia synthesis from a broad viewpoint.

Among the most important phases of the problem is the development of suitable catalysts for accelerating the combination of nitrogen and hydrogen, and the testing of these catalysts under a wide range of conditions. The laboratory has prepared hundreds of catalysts, has developed testing plants for their study and has investigated their behavior over a wide range of pressure, temperature and other conditions.

After 2 years of intensive work the point has been reached where it is felt that an important service can be rendered to the scientific and industrial world by the publication of a series of papers containing a considerable part of the results obtained. It is by no means felt that the problem has been solved, but it is believed that the results so far obtained may enable the industries interested in nitrogen fixation to hasten their development, and may contribute materially toward the understanding of the complex phenomena of contact catalysis. The facts and theories in the published papers should be understood as representing the present status of the catalyst problem, in so far as the Fixed Nitrogen Research Laboratory is concerned, and not as any final word upon the subject.

In connection with these papers the laboratory wishes to acknowledge the aid of a number of men who have been or still are associated with the work and who have contributed materially to its progress, but whose names do not appear in the published papers. These include Dr. Arthur B. Lamb, former director of the laboratory; Dr. W. C. Bray, former associate director; Dr. R. O. E.

Davis of the Bureau of Soils, and Dr. Graham Edgar, consulting chemist.
RICHARD C. TOLMAN.

VALUE OF TESTS AT ATMOSPHERIC PRESSURE

A catalyst suitable for the commercial synthesis of ammonia from nitrogen and hydrogen will undoubtedly be required to operate at high pressures. Therefore, in an investigation of catalyst materials, the final tests must be made at high pressures; certainly unless it can be shown that the behavior of catalysts at high pressures can be rigorously predicted from the results of tests at lower pressures.

Testing at high pressures is, however, a slow, laborious and rather expensive procedure, not well suited for the rapid preliminary study of a large number and variety of catalysts. Testing at atmospheric pressure is relatively simple and rapid and the apparatus for it can be quickly installed from more or less standard laboratory equipment. This paper discusses the general procedure and describes the equipment which has been employed in the Fixed Nitrogen Research Laboratory for testing ammonia catalysts at atmospheric pressure.

OUTLINE OF COMPLETE APPARATUS AND GENERAL PROCEDURE

Before discussing individual items in detail it seems advisable to consider briefly the apparatus as a whole, referring to Figs. 1 and 2 for illustration.

Ammonia gas, expanded to atmospheric pressure from liquid ammonia, is passed through an electrically heated

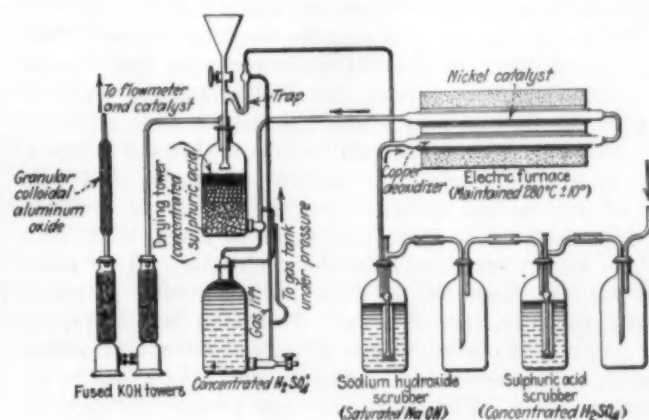


FIG. 1—ARRANGEMENT OF PURIFICATION SYSTEM

“cracker,” in which it is decomposed into the 1:3 nitrogen: hydrogen mixture used for testing. This gas is then passed into a gasometer, from which it enters a purifying system (Fig. 1) consisting of a sulphuric acid scrubber to remove undecomposed ammonia; a sodium hydroxide scrubber to remove acid; a deoxidizer of heated copper; a heated nickel catalyst for hydrogenation of carbon monoxide and other substances; a drying tower of concentrated sulphuric acid; two towers of fused KOH;

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¹For a discussion of the history, organization and purposes of this laboratory, see Tolman, this journal (vol. 24, No. 14, April 6, 1921, p. 595). It should be noted that on July 1, 1921, the laboratory was transferred, with personnel and equipment, from the War Department to the Department of Agriculture.

and a tube of granular colloidal aluminum oxide. The purified gas then passes to a flowmeter and thence to the catalyst chamber proper (Fig. 2), a Pyrex glass tube heated in an ordinary combustion furnace and provided with devices for exact regulation and measurement of temperature. From the catalyst chamber the gas passes into absorption bulbs for analysis. When experiments are to be carried out upon moist gas, there is inserted in the line following the purification train a humidifier, from which the gas enters the catalyst chamber containing a definite amount of water vapor.

In general, the catalyst is introduced into the furnace in the form of metallic oxide and is reduced to metal *in situ* by heating in the same current of pure nitrogen:hydrogen used for testing. This procedure will be discussed more fully in the fourth article of this series.

SOURCES OF NITROGEN:HYDROGEN MIXTURES FOR TESTING

Commercial compressed nitrogen and hydrogen in cylinders, provided with reducing valves and flowmeters, may, of course, serve as the source of the 1:3 nitrogen:hydrogen mixture used for testing. However, such gases are apt to contain considerable amounts of impurities, and the precise regulation of the composition of the mixture presents an additional complication.

By decomposing ammonia gas by heat, a gas mixture is obtained of definite and invariable composition, containing nitrogen and hydrogen in the ratio desired for testing. Furthermore, by this method a large and readily adjustable supply of the gas mixture is supplied from a small and compact apparatus. This procedure has therefore been adopted for preparing the gases used in the experiments reported in this series of articles.

THE CRACKER

The construction of the ammonia cracker is shown in detail in Fig. 3. It consists essentially of three concentric cylinders 6, 5 and 3 in. in diameter, and 51, 50 and 63 in. long respectively, made from standard iron pipe and arranged as illustrated. Welded joints are used wherever screw connections are not shown.

The inner cylinder contains the heating element. This consists of 40 ft. of No. .04 nichrome wire first wound in a closed coil on a $\frac{3}{8}$ -in. mandrel and then stretched to give the desired length and spacing between adjacent turns of the wire. The coil is drawn through a 36-in. porcelain tube having an outside diameter of $1\frac{1}{2}$ in. and is then wound spirally upon the outside of the tube as indicated. The porcelain tube is fitted with iron guides which serve to hold the nichrome coil in place and also to keep the heating unit centrally disposed within the 3-in. iron cylinder. Porcelain insulators are put around the wire where it passes under the metal guides. The assembled heating unit rests upon an alundum plate. The lead wires are passed through an insulating tube and are attached to the central electrodes of standard $\frac{1}{2}$ -in. spark plugs. The lead wires are made sufficiently long so that each can be doubled back on itself. This tends to keep each lead relatively cool at the point where it is attached to the spark plug. A peephole of mica is provided at the top of the inner pipe, through which the heating coil may be observed for temperature regulation. The space between the 3-in. and 5-in. cylinders is packed with steel-wool and the whole apparatus is surrounded by a lagging of asbestos-magnesia. The ammonia gas enters at A, passes

over the hot steel-wool, then up around the heating coil and finally out at B or at C as may be desired.

The cracker operates directly on 110-volt a.c. current and consumes $6\frac{1}{2}$ to 7 amperes. It will decompose about 200 liters of ammonia gas per hour, leaving less than 0.01 per cent of ammonia in the cracked gas.

Attention should be called to the following details: (1) Joints are made gas tight at flanges D and E by the use of asbestos graphite packing. (2) All pipe and fittings indicated are standard, the leads to and from the cracker being made from $\frac{3}{8}$ -in. material. (3) The plate shown at the bottom of the 5-in. cylinder is welded on so as to make it gas tight. (4) The decomposer is essentially complete without the 6-in. outer shell. The ammonia gas, however, attacks the iron walls—that is, the 3-in. and 5-in. cylinders—and cracks are apt to develop which might cause considerable leakage of gas. The outer shell—that is, the 6-in. cylinder—serves pri-

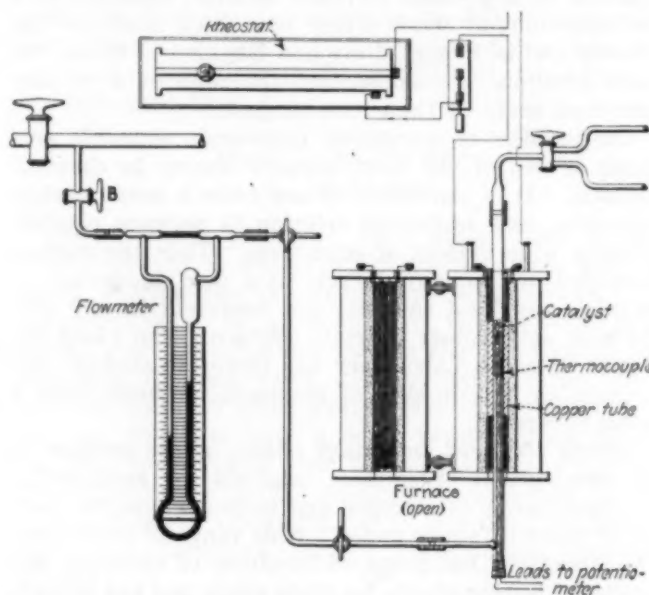


FIG. 2—FLOWMETER AND CATALYST TUBE AND FURNACE

marily to maintain the same pressure on both sides of the 5-in. cylinder. With this arrangement, even though the ammonia does attack the 5-in. cylinder, it does not become deformed, and leakage through this wall is avoided. It will be noted that the cracker may be operated in two different ways. First, the ammonia gas may be introduced at A and the decomposed gas drawn off at B. By keeping C closed the pressure on each side of the 5-in. cylinder remains the same, the pressure on the cracker as a whole being carried by the outside cylinder. Second, by closing the exit at B all the gas may be withdrawn at C. This has no advantage, however, over the first method suggested and in practice we prefer to withdraw the gas at B. At C we place a small cock from which we allow a very slow stream, say 5 to 10 c.c. per minute, of gas to escape.

In case the walls of the 3-in. and 5-in. cylinders do break down as a result of the action of the ammonia, this portion of the cracker may be easily removed by loosening the bolts in the flange E and withdrawing this portion of the apparatus. A replacement may then be introduced without disturbing the outer shell and the insulating material surrounding it.

Attention should also be called to the initial operation of a newly installed apparatus. The iron walls and piping are coated with oil, which is most conveniently

removed by heating the cracker slowly up to 500 to 600 deg. C. During this time a cylinder of cracked gas is attached at *B* and a slow stream of gas is allowed to escape at *A* and *C*. When the oil fumes have disappeared ammonia may be introduced at *A* and the cracker operated as indicated above.

For several days the efficiency of the cracker will be

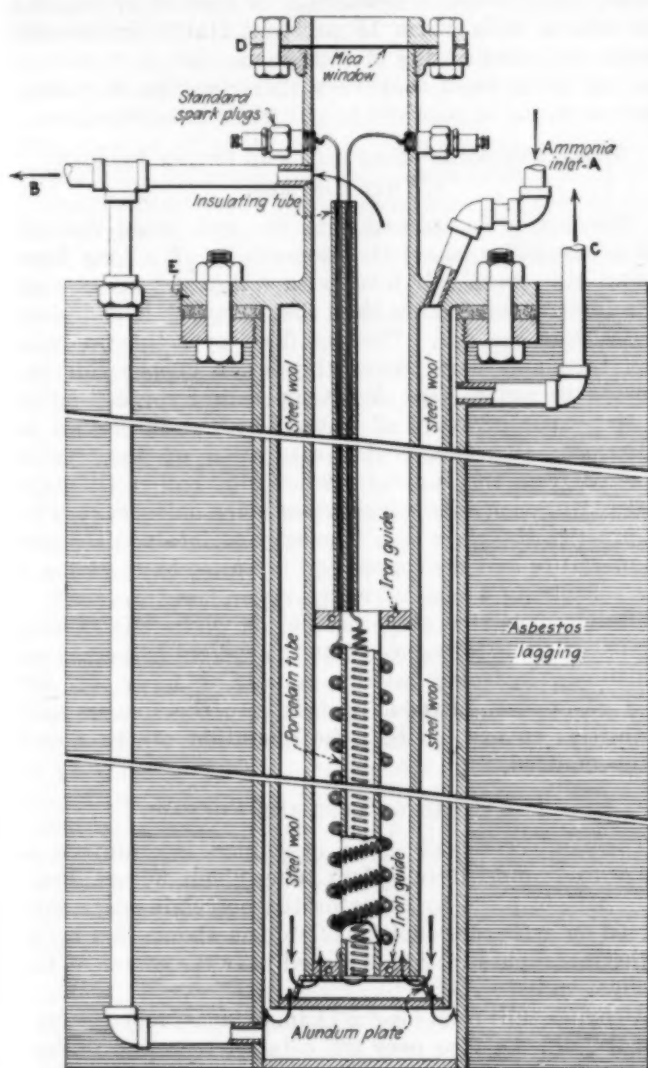


FIG. 3—SECTION THROUGH AMMONIA CRACKER

surprisingly low. After the steel-wool has become sufficiently activated so that the greater portion of the gas is decomposed in contact with its surface, the ammonia in the exit gases will be found to drop to about 0.01 per cent. The nichrome coil is heated to bright redness, the color of which can be observed through the mica window.

PURIFICATION OF THE GAS

The purification of the gas mixture is one of the most important factors, perhaps the most important factor, in determining the success of a catalyst-testing apparatus. Like most contact catalysts, the substances which are active in catalyzing the synthesis of ammonia are extremely susceptible to poisons. No intelligent conclusions as to the behavior of a catalyst can be drawn unless the gas used for testing is of the highest degree of purity or else contains definite and known quantities of particular impurities when desired. The poisons most frequently encountered are water vapor, carbon monoxide and acidic constituents. The purification

train described below is designed to remove undecomposed ammonia which may have escaped the cracker and also any catalyst poisons which may be present in the cracked gas. What is equally important, it does not introduce impurities into the gas flowing through it, a source of error that is not always sufficiently guarded against.

DETAILS OF PURIFICATION SYSTEM SCRUBBERS

The individual items of the purifying system (Fig. 1) are described in detail below.

The concentrated sulphuric acid scrubber not only removes any undecomposed ammonia but also serves to absorb any unsaturated hydrocarbons which might be present in the liquid ammonia from which the nitrogen:hydrogen mixture is made. In order to avoid possible reduction of the sulphuric acid, with consequent introduction of sulphur dioxide into the gas, a little potassium dichromate is added to the acid.

The sodium hydroxide scrubber serves to remove acid spray picked up from the sulphuric acid and other acidic impurities possibly present. The solution is kept saturated with sodium hydroxide in order to keep the moisture content of the gas as low as possible.

THE DEOXIDIZER

The gas passes from the alkali scrubber into a tube filled with metallic copper, and is heated to about 280 deg. C., which serves to remove the traces of oxygen which may be present. Whereas a fairly satisfactory copper catalyst for removal of oxygen from nitrogen:hydrogen mixtures may be made by low-temperature reduction of granules of commercial c.p. copper oxide, such a catalyst should be operated above 300 deg. C. for best results. Since in the present apparatus it is desired to heat the copper and nickel catalyst in the same furnace and since the nickel catalyst should not be heated above 300 deg. C. (see discussion following), a special copper catalyst is used. The catalyst is prepared as follows: A 6 to 8 per cent solution of copper nitrate is heated to 40 to 50 deg. C. and slowly added to a 5 to 6 per cent solution of warm sodium hydroxide in slight excess. The mixture is vigorously stirred while precipitation takes place. The precipitate is permitted to settle and the supernatant liquid is siphoned off. After thorough washing by decantation, the precipitate is washed dry on a Buchner funnel and the filter cake broken into 1-in. cubes and dried in a ventilated oven. During the first 12 hours the temperature of the oven is held at 80 to 90 deg. C. The temperature is then raised to 125 to 150 deg. C. and the drying continued for 24 hours. The hard compact granules are then broken up and screened to 4 to 8 mesh, which proves to be a convenient size.

The oxide is now placed in a catalyst tube, as shown in the figure, and is gradually heated to 300 deg. C. in a current of pure, dry nitrogen:hydrogen mixture. This reduced copper oxide is found to be highly pyrophoric, so considerable care must be exercised in keeping it from being exposed to the air. It has been found to work satisfactorily as a deoxidizer at 280 deg. C.

THE NICKEL CATALYST

From the deoxidizer the gas passes through a tube filled with a nickel catalyst, heated in the same furnace as the copper catalyst. Greenwood and Cowper (Munitions Invention Department, Ammonia Synthesis No.

12) have shown that small amounts of carbon monoxide are completely removed from hydrogen even at high space velocities by passing the gas over a properly prepared nickel catalyst at 250 to 300 deg. C. The carbon monoxide is converted into methane, which is inert toward ammonia catalysts. In addition to carbon monoxide, unsaturated hydrocarbons may be hydrogenated by the nickel. It may be noted that this catalyst would also remove oxygen from the gas (Greenwood and Neville, Munitions Invention Department, Ammonia Synthesis No. 65), but a rapid deterioration of the catalyst results from its exposure to high temperatures, and since this effect may be produced if appreciable quantities of oxygen are present, it was thought safer to precede the nickel by the copper catalyst described above.

The preparation of the nickel catalyst follows Greenwood's specifications. Nonpareil brick, crushed and screened to 4 to 8 mesh, is impregnated with sufficient nickel nitrate solution so that on subsequent ignition and reduction the product contains 10 per cent of metallic nickel. The material is dried at 150 deg. C., is placed in a catalyst tube, and is reduced at as low a temperature as possible in hydrogen or a nitrogen:hydrogen mixture. The catalyst is operated at 280 deg. C. \pm 10 deg.

FINAL SCRUBBERS AND DRIERS

From the nickel catalyst the gas passes to the sulphuric acid scrubbing tower containing broken glass and beads over which fresh concentrated sulphuric acid is circulated. The acid flow is maintained by a gas lift operated by an auxiliary supply of nitrogen:hydrogen mixture under pressure. The flow is adjusted by a reducing valve and a needle valve. It will be noted (Fig. 1) that the acid from the lift is caught in the trap, from which it trickles into the scrubbing tower. By this means introduction of any acid spray produced by the lift is avoided. The gas used to operate the lift is returned to the main line just ahead of the copper deoxidizer, thus avoiding wastage of gas.

If the acid in the scrubbing tower is kept reasonably fresh, a gas containing less than 0.001 per cent of water may be expected.

The acid scrubber is followed by two towers of fused KOH, which is an excellent drier and also serves to absorb any volatile acidic constituent which might be absorbed by the gas from the concentrated sulphuric acid.

From the KOH towers the gas passes into a tube containing highly porous aluminum oxide, which takes up water very effectively and also serves as a general absorbent, being particularly effective in removing any readily condensable gases.

The preparation of aluminum oxide is similar to that described above for the copper oxide, except that somewhat more dilute solutions are employed, that ammonia is used as precipitating agent, and that the precipitate is washed more thoroughly. The final drying is at 285 to 300 deg. C. The dried granules (6 to 8 mesh) are highly absorptive, and must therefore be kept out of contact with moist air.

CONNECTING TUBING

The gas issuing from the purification system passes into a copper manifold of $\frac{1}{4}$ -in. copper tubing, from which in turn connection is made to twelve catalyst furnaces. A glass manifold, originally employed, was abandoned because of loss of time when breakage oc-

curred. A manifold of standard iron piping was found to contaminate the gas, while a copper manifold has proved thoroughly satisfactory.

It should be noted that rubber tubing is to be avoided whenever possible. For example, 80 cm. of cold-cured tubing lowered the activity of a particular catalyst 95 per cent, and vulcanized tubing produced a similar effect. Considerable improvement is effected by treating the tubing with warm 10 per cent NaOH for several hours and then drying it; but in no case is it safe to use anything more than very short lengths of tubing, such as might be required to join glass tubes together.

INTRODUCTION OF MOISTURE AND OTHER POISONS WHEN DESIRED

Moisture is introduced into the gas, when desired, by a humidifier, consisting essentially of a long horizontal glass tube half filled with water and maintained at a higher temperature than that at which it is desired to saturate the gas. The gas flows over the water in this tube and then passes through a copper coil immersed in water, kept at a temperature corresponding to the vapor pressure of water which it is desired to introduce. By this device saturation of the gas is effected from the supersaturation side rather than the undersaturation side, which gives more uniform results. In practice the glass bulb is usually maintained at room temperature and the copper coil in an ice bath, giving a gas containing 4 mm. of water vapor.

Carbon monoxide, the other poison whose effects have been studied, is introduced into the system by preparing a nitrogen:hydrogen mixture containing 1 per cent CO in a gasometer, introducing this into the line in such quantities as are desired, the operation of the nickel being omitted.

THE CATALYST TUBE AND FURNACE

The catalyst, usually 5 c.c. in volume, is contained in a 12- to 14-mm. Pyrex glass tube, about 30 cm. long. It is held in place by a perforated porcelain plate supported on a thermocouple insulator as shown in Fig. 2. A thermocouple junction is placed near the center of the catalyst mass.

A copper tube 6 in. long x $1\frac{1}{4}$ in. external and $\frac{5}{8}$ in. internal diameter slips over the catalyst tube and is supported by stout wires from the top of the furnace. The function of this tube is discussed below. The copper and glass tubes fit into a multiple unit (type 70) furnace with hinged top, connected in series with a rheostat. The furnace is employed in a vertical position, as shown in Fig. 2.

CONTROL THE MEASUREMENT OF GAS FLOW

The purified gas from the manifold passes through the cock B (Fig. 2), which serves to control the gas flow, and then passes through an ordinary glass flowmeter, from which direct connection is made to the catalyst tube as shown in the figure. The flowmeters are carefully calibrated by water displacement, using a stopwatch, and are known to be accurate within 5 per cent.¹

CONTROL AND MEASUREMENT OF TEMPERATURE

Temperature control in the cracker and in the copper:nickel catalyst furnace, requiring only approximate regulation, is effected by appropriate rheostats and is

¹A discussion of the details of construction and calibration of these flowmeters is given in *J. Ind. Eng. Chem.*, vol. 11, p. 623 (1919).

measured optically in the case of the cracker and by a thermocouple in the catalyst furnace.

Temperature control and measurement in the catalyst furnace, however, represent a very important problem. In order to be able to draw correct conclusions concerning the behavior of catalysts, it is essential that all parts of the catalyst mass be at the same temperature and that the recorded temperatures be identical with those actually existing.

Uniformity of temperature is not easily obtainable in commercial types of tube furnace. Thus in the furnace employed in this investigation, there was a temperature difference of 10 to 25 deg. C. between top and bottom of the 4 c.c. of catalyst mass. These temperature differences did not vary appreciably with the rate of flow of the gas, showing that they were characteristic of the furnace itself. In order to eliminate these differences it is absolutely essential to smooth out the temperature gradient of the furnace, at least for the distance occupied by the catalyst. The external copper tube, previously described, effects this result most satisfactorily, the high thermal conductivity of the copper serving to distribute the heat in such a way that practical uniformity of temperature is secured throughout the entire catalyst.

A rheostat having fine gradations and connected in series serves to effect a very close adjustment of temperature.

Temperature is measured by means of a chromel-alumel thermocouple with its junction imbedded in the lower layers of the catalyst. The thermocouple wires are insulated by means of a two-holed fireclay protection tube which is supported at its lower end by a rubber stopper. The wires are sealed gas tight in the end of the fireclay tube by means of de Khotinsky cement. Below the rubber stopper the thermocouple wires are attached to copper wires leading to a Leeds & Northrup potentiometer, sufficiently sensitive to permit the estimation of temperature to 1 deg. C. The thermocouples are frequently calibrated by heating them in a vapor bath of boiling sulphur.

ANALYTICAL CONTROL

Since the effectiveness of the catalyst is determined by the ratio of ammonia to nitrogen:hydrogen in the outflowing gas, this represents the only necessary analytical determination. At atmospheric pressure the amount of ammonia must always be very small, necessitating the use of a large sample of gas for analysis. In practice, therefore, a Gomborg gas-washing bottle containing standard sulphuric acid is attached to the outlet gas, and the gas current is maintained for a definite time, the flowmeter and stopwatch readings permitting the calculation of total gas volume. The ammonia is then determined by titrating the excess of acid with standard alkali, using methyl red as indicator.

RESULTS

The apparatus described above has been employed in the Fixed Nitrogen Research Laboratory for the testing of a large number of ammonia catalysts and for studying the influence of temperature, rate of flow of gases, catalyst poisons and other factors entering into catalyst behavior. Results of these investigations will appear in the fourth article of this series.

(Part II, which discusses Small-Scale Testing of Ammonia Catalysts at Variable Pressures, will be published in a subsequent issue.)

Cancer From Handling Anthracene Cake in the Dye Industry

The use of anthracene, which is the starting point of the alizarine dye industry, has been shown by W. J. O'Donovan,¹ writing in the *British Journal of Dermatology and Syphilis*, to be capable of producing cancer of the skin among workers handling the crude anthracene cake. Anthracene in the cases reported was delivered to the factory in the form of cake which was unloaded by hand and broken down, exposed to steam, and washed with solvent naphtha mixed with pyridene bases; the product was then distilled with potash and lime, washed with solvent naphtha, and finally sublimed.

The three cases reported were brought to the writer's attention within a period of about 4 months, and in a factory employing only about twenty-five men this was considered by him as "a heavy incidence of a grave industrial disease."

The first case was that of a man 62 years old who had been employed for 5 years in unloading boxes and sacks containing the raw cake. On the back of the right wrist was an ulcer with raised edges which proved to be a scaly and horny-celled carcinoma. The growth which was removed had started as a small wart 6 months previously. His forearms also showed much dilatation of the capillaries and small blood vessels and follicular keratoses, a form of acne. The second case occurred in a man aged 53 who had worked for 30 years in the same factory. A cancer of the same nature had appeared on his right cheek 3 months before and had grown very rapidly. Under treatment by radium it entirely disappeared. The third case was that of a man 59 years of age who had worked in the factory 32 years and who had developed an ulcer on the right wrist 4 years previously. This ulcer had developed rapidly in the preceding 6 months and upon excision was found to be a cancer of the same nature as in the other two cases.

All the men working in this factory who in any way handled the crude anthracene showed a deep staining of the hands and faces. Their hands were stained a deep brown, sometimes almost green, their faces and necks were very swarthy and there were also acne papules on their necks and forearms.

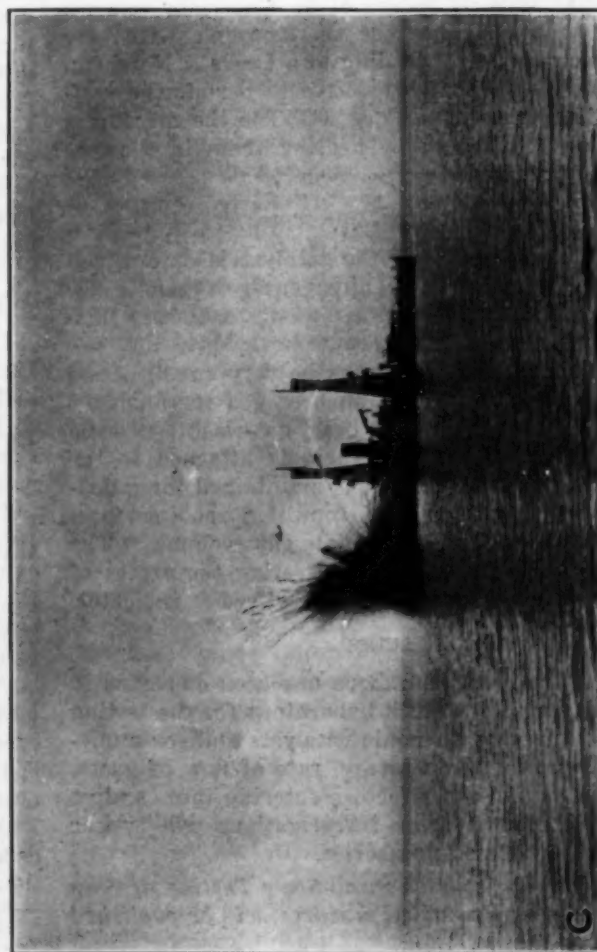
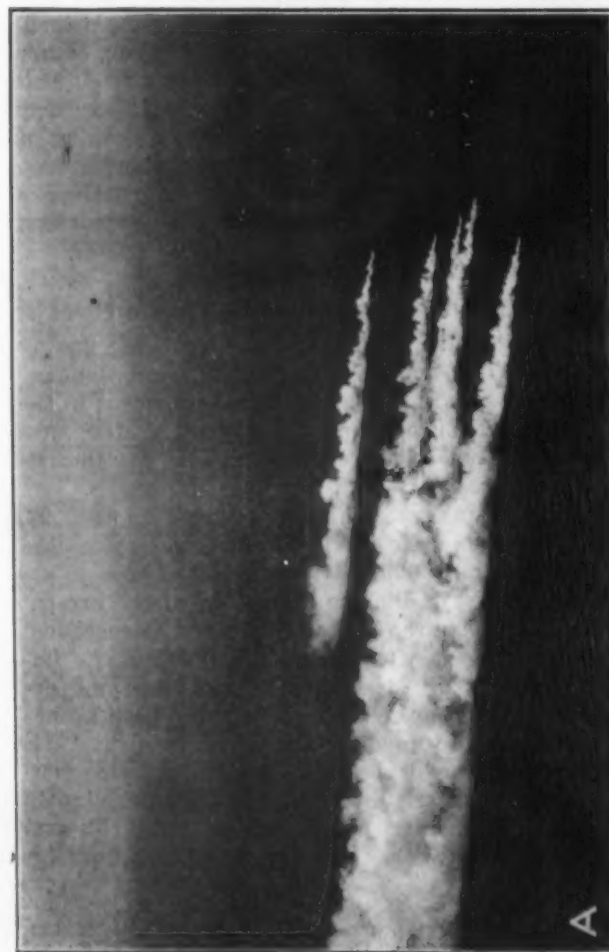
Business in Chile Awaits Lower Nitrate Price

Conditions in Chile, reported to be improving during December, 1921, remained stationary during January and February and are still awaiting a betterment in the nitrate trade of Europe and the United States, says Commercial Attaché McQueen in a cable to the Department of Commerce.

The prices on nitrate which were fixed on Oct. 27, 1921, terminate on June 30, 1922, and lower prices are expected thereafter. The nitrate producers hope to see the reduced prices hasten the marketing of the present stocks in Europe and the United States and a consequent general improvement after the middle of the year. Imports and exports are decreasing, the foreign and domestic demand continuing dull. There has been no appreciable addition to import stocks since October, 1921.

The agreement made between the miners and operators of the coal districts of southern Chile terminated Dec. 31, 1921, following which a walkout and strike was called. This, however, has recently ended in failure for the miners.

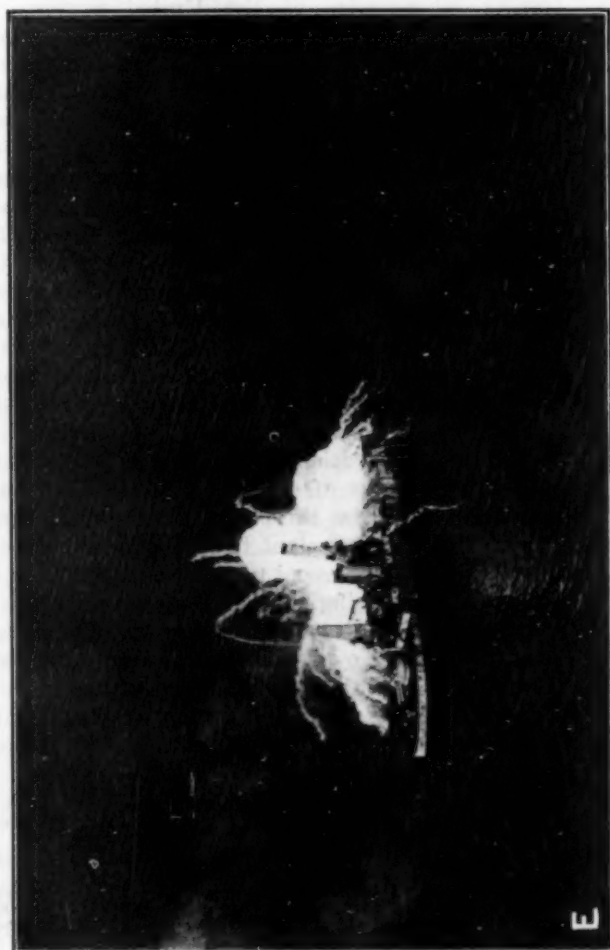
¹*Boston Medical and Surgical Journal*, Dec. 1, 1921, pp. 662, 663. *Journal of Industrial Hygiene*, December, 1921, pp. 187, 188.



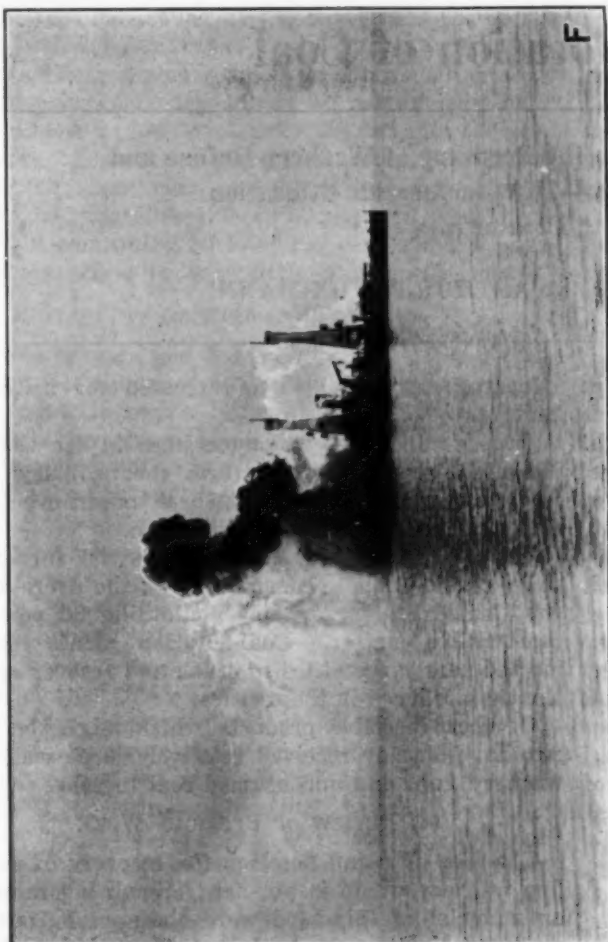
Chemical Warfare in Naval Action

This Is the Ghost the Navy Saw in the Bombing of the Alabama and Explains Its Attitude Toward Gas Warfare

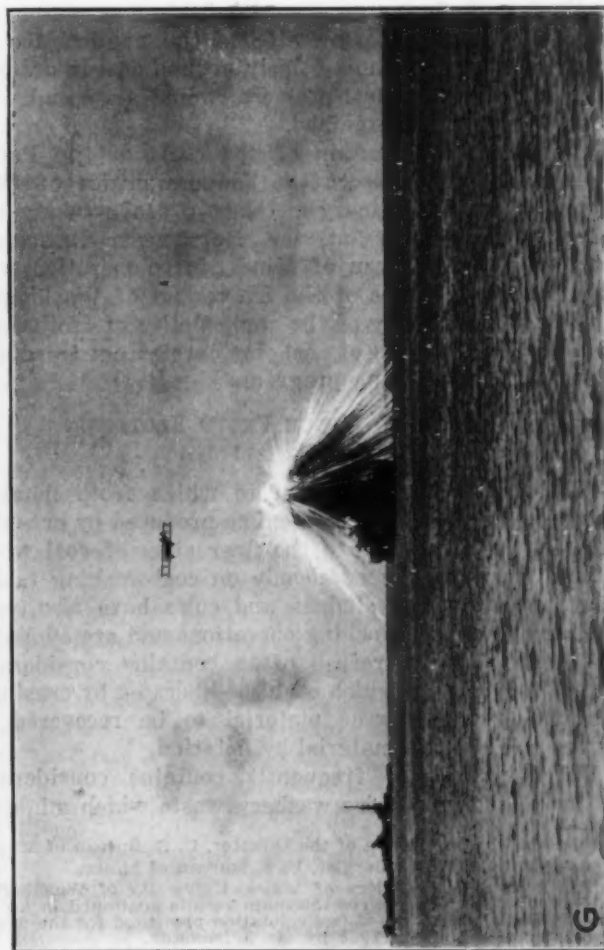
A and B—The Alabama in a Smoke Screen
C and D—Effect of 25-Lb. Phosphorus Bomb
E and F—Direct Hits With Two 25-Lb. Phosphorus Bombs
G—100-Lb. Phosphorus Bomb Hits Crow's Nest
H—Direct Hit of Four 100-Lb. White Phosphorus Bombs
I—Direct Hit of Four 100-Lb. White Phosphorus Bombs



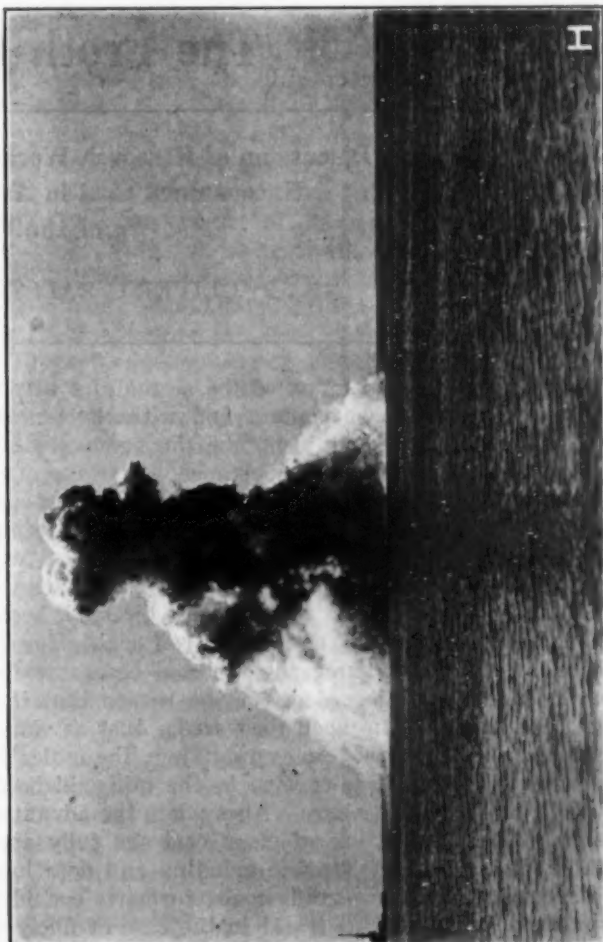
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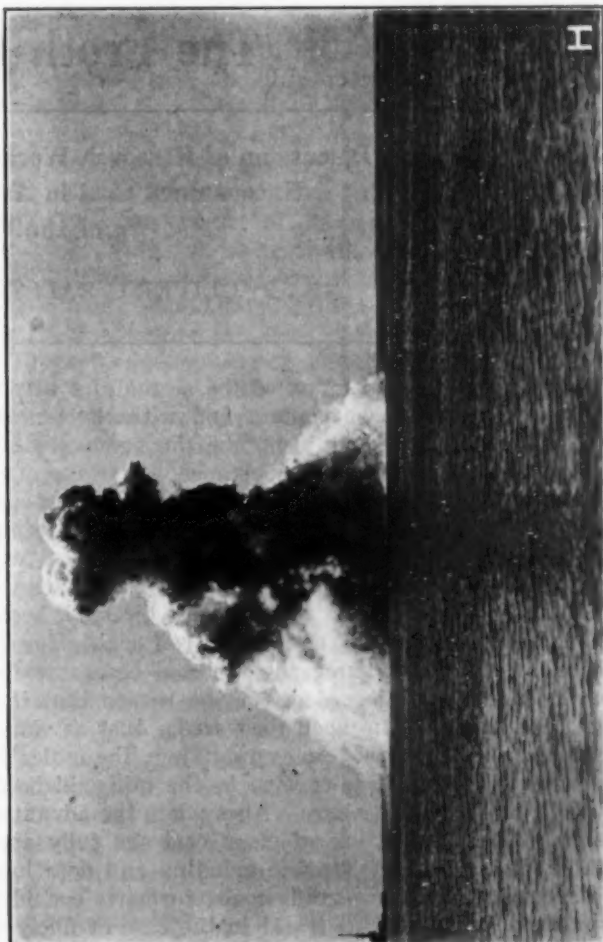
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The Froth Flotation of Coal

A Discussion of Research Work on the Recovery of Washery Refuse and Unconsumed Coal in Ashes—The Commercial Utilization of the Froth Concentrate

BY OLIVER C. RALSTON¹ AND ARTHUR P. WICHMANN²

WITH the exhaustion of the seams of coal which are low in ash content and with the increased cost of coal, problems in the removal of ash have assumed increasing importance. The use of jigs for removing the slate and other impurities from coarse coal has long been standard practice. More recently, ore-concentrating tables have been adapted to the "washing" of the finer sizes of coal in the coal washeries and have saved material that was formerly wasted, because there is a poor market for fine sizes of coal. However, the slime formed in breaking the coal before washing has been entirely discarded, for the reason that it has not been salable even when recovered. Just as was the case in ore-dressing not many years ago, the indications are now that the slime formed in the mill will become sufficiently valuable to save. Also, when the advantages to be gained by the use of clean coal are fully appreciated, it is possible that fine grinding and flotation or other treatment of low-grade coals, formerly considered worthless, will result as it did in the case of finely disseminated ores. While it is not at all certain that such methods will find a commercial field, it was thought well worth while to investigate the applicability of froth flotation to cleaning finely ground coal in order to see just what technical problems would arise and what advantages could be gained.

Since an investigation of the coals of the Pacific Northwest with respect to the possibilities of their improvement by ordinary methods of coal washing was already under way at the Northwest Experiment Station of the Bureau of Mines, in co-operation with the College of Mines of the University of Washington at Seattle, this study of the applicability of froth flotation to the fine sizes of coal was carried out to supplement the coal-washing program.

PRODUCTS TO WHICH FROTH FLOTATION MIGHT BE APPLIED

The most obvious product to which froth flotation might be applied is the coal slime produced by crushing coal in washeries and to the finer sizes of coal which cannot be washed very cleanly on coal-washing tables. Huge piles of coal sludges and culm have also accumulated from past washing operations and are available.

Coarse washery refuse often contains considerable interstratified coal which could be liberated by crushing, permitting the coarser material to be recovered by tables and the fine material by flotation.

Mine waste also frequently contains considerable material like the coarse washery waste which might be

advantageously crushed and treated for its coal content.

Run-of-mine coal, when too high in ash that is not liberated by crushing to form the ordinary sizes of lump, egg, nut, pea and buckwheat, might even be more finely ground and treated by flotation.

The ash from domestic and industrial furnaces contains considerable unconsumed coal, the average ash of the United States probably containing 20 per cent of combustible matter. Coal-flotation plants might be located near large cities to crush and recover coal from the ash produced in these cities.

Of these possible products which might be treated, two have already received relatively large-scale tests—washery fines and unconsumed coal in ashes.

REVIEW OF PREVIOUS WORK

The idea of using flotation for recovery of coal from fine washery waste is not new. Small laboratory tests on material of this kind were observed by one of the present writers as far back as 1915 in various flotation-testing laboratories of the United States. In one instance the film flotation machines of the Empire Zinc Co., in Canyon City, Col., had been tested for recovery of anthracite from the anthracite culm material known to be so plentiful in Pennsylvania, cleaner concentrate being obtained than by froth flotation. The idea had been passed around in a confidential way among flotation engineers. The first U. S. patent was issued to Raymond F. Bacon, of the Mellon Institute, Pittsburgh, Pa. (U. S. Patent 1,329,493, of Feb. 3, 1920), who assigned it to the Metals Recovery Co. of New York. Bacon described tests with a Callow pneumatic flotation test machine on coal washery waste and on run-of-mine coal crushed to pass a 48-mesh screen and mentioned the fact that lustrous coal in sharp angular fragments was the most easily floated.

Minerals Separation, Ltd., in England, also began patenting features of coal flotation³ in 1919 and later⁴ in that year built at the plant of the Skinningrove Iron Co., in Wales, a test plant to investigate the removal of ash from the coking coal used by that company, a problem which was giving considerable concern. The reports on this work appeared after the present writers had done all of their own work and not only checked their observations but supplemented them to some extent.

In view of this prior publication we shall not attempt to report our own results in detail but shall give them

¹Published by permission of the Director, U. S. Bureau of Mines.

²Assistant Chief Metallurgist, U. S. Bureau of Mines.

³Research Fellow, College of Mines, University of Washington, 1919-1920. This paper gives the main results contained in an extensive thesis on the use of froth flotation presented for the degree of Master of Science in 1920 by Mr. Wichmann.

⁴Br. Pat. 154,702, Mellersh-Jackson, Sept. 2, 1919; Br. Pat. 155,875, W. Broadbridge, Aug. 26, 1919; Br. Pat. 159,285, Edser, Rulman and Jones, Nov. 20, 1919; Br. Pat. 165,144, Jones, Bury and Minerals Separation, Ltd., 1920.

⁵Arnold F. Bury and Arthur Bicknell, *Colliery Guardian*, vol. 120, p. 337 (1921). Ernest Bury, W. Broadbridge and A. Hutchinson, *Trans. Inst. Min. Eng.*, vol. 60, pp. 243-253 (February, 1921); also *Colliery Guardian*, vol. 121, pp. 867-868 (1921); also *Chem. Eng. and Min. Rev.*, vol. 13, pp. 388-390 (1921). Anonymous, *Iron and Coal Trades Review*, vol. 102, p. 197 (1921).

only in abstract, reviewing at the same time the work which has been done in Wales.

The material in a coal seam may contain all gradations from pure coal with almost no ash to pure ash. It has been more or less arbitrarily divided into the following types of material: Pure coal, containing up to 5 per cent ash; bony coal, containing from 5 to 15 per cent ash; bone, containing 15 to 50 per cent ash; bituminous shale, containing 50 to 80 per cent ash and pure shale rock or ash with very little bituminous matter.

THE SUITABILITY OF VARIOUS FLOTATION OILS

In all the various coals tested it has been found that the pure coal is the most easily floated,¹ and the other products follow in order. Since the division between them is merely arbitrary, their behavior in the flotation machine is quite similar and it is almost impossible to distinguish visually one from the other in the froth. The most favorable oil discovered in the work in England was the waste water from the absorption and washing of crude naphthalene in an adjacent byproduct coking plant, whereas our most favorable oil was a mixture of alphanaphthalamine (known to the flotation trade as X-cake) with xylydine in sufficient quantity to keep it in solution. Both of these are practically entirely water solutions of coal-tar products and seem to be adapted best to making the pure coal float first. They are commonly regarded as "frothers" and not very good collectors. When petroleum products or other wood or coal-distillation products such as creosotes, tars or essential wood oils are added, the flotation of the other portions of the coal results.

The British experimenters have said: "If we were asked to state the most striking fact in the application of the process to coal washing, we would refer without hesitation to the facility with which it separates one grade of coal from another merely by the simple control of reagents and without the aid of any form of screening or classification." This observation we are unable to check. Our work has been almost entirely restricted to the bony coals and bone coals of the Pacific Northwest and we have observed a marked tendency of the coal to separate in this manner, but we certainly cannot feel that this is done with any "facility." Had we been working with some of the fine low-ash coals of Wales we might have been able to agree.

If a high extraction of combustible matter is the desideratum rather than low ash concentrate, any of the ordinary flotation oils easily recovers all the pure coal, bony coal and bone together. There is no difficulty whatever in getting coal to enter a flotation froth and in fact we have found our greatest embarrassment in the tendency of all the bituminous matter to float with the clean coal. Pine oil and similar frothers cause trouble of this kind. Quite evidently the best condition for the procurement of a clean coal froth is a relatively poor flotation condition, just as in the differential flotation separation of mixtures of sulphide minerals conditions must be found under which one mineral can barely be floated while the other or others will not float at all.

SKINNINGROVE IRON CO. TESTS

This test plant, as well as one built at the Powell-Duffyn Colliery, Aberdare, England, treated the high ash products obtained in the washery where a coking

coal was prepared for the ovens. The material liberated a high percentage of low-ash coal by simple crushing to pass a 10-mesh sieve, and this material was treated in Minerals Separation flotation machines, using as a flotation reagent the wash water from the naphthalene recovery section of the byproducts coking plant. The ingoing material contained from 13 to 45 per cent ash and the froth concentrate of cleaned coal contained as low as 3.5 per cent ash—a truly remarkable result when compared to what can be done with the ordinary types of coals available in the United States. A screen analysis of the froth concentrate shows that the material passing a 10-mesh and stopping on a 20-mesh screen contains only 2.7 per cent ash, while the material passing a 200-mesh screen contains 5.9 per cent ash, the tendency being for progressively smaller sizes of the coal in the concentrate to be progressively dirtier. Our own results on higher-ash coals check this.

The froth was thickened in a Dorr tank to 50 per cent solids and then passed over an Oliver continuous filter, yielding a product said to contain about 10 per cent moisture. It was felt that this was too much moisture to be fed economically into the coke ovens and preparations were being made to reduce it further in a drier. Nevertheless this material was easily coked in ordinary byproduct ovens and the low-ash coke afforded a considerable economy, estimated at slightly over 3 shillings per ton of pig iron produced with the coke. The advantages of treating the coking coal by this method in order to make coke for the iron industry are summarized by Bury, Broadbridge and Hutchinson as follows:

ADVANTAGES OF THE METHOD

(1) Ash reduction. Saving in cost of handling, particularly where the place of the production of material to be coked is some distance from the coke ovens.

(2) Economy in coking. The product is more highly bituminous, yields richer gas, more byproducts and about the same yield of coke.

(3) Superior coke. The coke produced is low in ash and also highly porous but very strong and dense.

(4) Economy in furnace space. More room for iron ore and fuels.

(5) Minimum silica, since ash reduction calls for less lime and hence less coke.

(6) Dense coke means less fines. This avoids loss of coke fines and must be screened out.

(7) Thermal efficiency. Less slag produced to carry out heat.

(8) Maximum thermal efficiency at smelting zone, because coke does not shatter and burn up before it reaches this zone.

A typical test on this Welsh coal containing 10.14 per cent ash gave 87.2 per cent by weight of pure coal concentrate with 3.25 per cent ash, 2.4 per cent second concentrate (bone) with 19.2 per cent ash and 9.5 per cent of residue with 72.1 per cent ash.

This work in England proved to be very valuable and profitable to those entering into it for the reason that it was possible to recover cheaply from the old waste dumps that had accumulated for years a great deal of coal at a time when the nation was suffering from coal shortage caused by strikes and high cost of production.

RECOVERY OF COAL FROM ASHES

The unconsumed coal in domestic and industrial ashes, mentioned as one of the products to which flotation should be applicable, has been experimented on by

¹One exception to this has been reported in a private communication from the superintendent of the Rare and Precious Metals Experiment Station at Reno. A bony lignite from western Nevada gave a first concentrate higher in ash than the later products taken from the flotation machine.

Fraser and Yancy* at the Urbana experiment station of the Bureau of Mines, where rather large tests were made on the use of coal-washing tables for this work. The ashes were crushed to about $\frac{1}{2}$ to $\frac{1}{4}$ in. before tabling. The washed fuel recovered contained about 25 per cent ash. Such material has been tested qualitatively by the writers, using froth flotation, and the combustible material forms a black froth in sharp distinction to the light-colored ash suspended in the water. However, no quantitative tests have been made. H. B. Hoveland, in his laboratory in Washington, D. C., was one of the first to use froth flotation on such ash, but his results were not available.

FROTH FLOTATION OF PACIFIC NORTHWEST COALS

Representative results of some of our tests on the coals of the Pacific Northwest are briefly abstracted in Table I. They were obtained when we were learning how

Coal Treated	Source	Feed	First Con-		Second Con-		Tailing	
		Per Cent Ash	Weight Per Cent	Ash Per Cent	Weight Per Cent	Ash Per Cent	Weight Per Cent	Ash Per Cent
Sub-bituminous...	Renton, Wash.	19.4	32.0	10.7	35.0	14.0	33.0	33.2
Sub-bituminous...	Bellingham, Wash.	22.7	70.0	13.5	15.0	26.9	15.0	57.0
Bituminous...	Roslyn, Wash.	17.8	33.0	10.1	49.0	11.4	19.0	51.0
Bituminous...	Roslyn, Wash.	17.9	77.0	12.4	19.0	30.1	4.0	73.3
Coking bituminous...	Carbonado, Wash.	8.0	61.6	4.4	34.1	9.8	3.4	62.5

Incidentally, the oil mixture used in this test was found to be rather non-selective and too much of a collector. It consisted of 50 per cent hardwood creosote and 50 per cent coal tar creosote used in the proportion of 2 lb. per ton of coal.

A few representative figures showing the way in which a coal tended to divide into several products, the

TABLE I.

Product Treated	Source	Per Cent Ash		Per Cent Recovery	Oil Used		Lb. Per Ton
		In Feed	In Concentrate		Kind		
Sub-bituminous table middling	Mendota, Wash.	47.85	25.66	71.2	Pine oil (steam-distilled)		1.5
Sub-bituminous run-of-mine	Renton, Wash.	28.75	23.75	44.9	Coal tar-pine oil		2.0
Sub-bituminous washery sludge	Renton, Wash.	19.38	10.66	34.6	Coal tar-hardwood oil		3.0
Sub-bituminous fine screenings	Bellingham, Wash.	22.65	13.30	54.1	Hardwood creosote		2.0
Sub-bituminous run-of-mine	Isaquah, Wash.	33.25	22.38	33.6	Kerosene-pine oil		8.0
Sub-bituminous washery sludge	Isaquah, Wash.	29.35	17.10	11.8	Kerosene-pine oil		2.0
Coking bituminous, table middling	Palmer, Wash.	30.01	20.00	76.7	Pine oil		0.5
Coking bituminous, run-of-mine	Carbon Co., Utah	6.00	4.00	61.4	Pine oil		0.7
Coking bituminous, run-of-mine	Ladysmith, B. C.	8.60	4.95	73.7	Pine oil		0.25
Non-coking bituminous, run-of-mine	Roslyn, Wash.	17.80	9.98	56.1	Pine oil		0.6
Non-coking bituminous, run-of-mine	Roslyn, Wash.	24.15	13.43	72.6	Kerosene oil		1.0
Non-coking bituminous, run-of-mine	Carbonado, Wash.	18.65	10.37	60.0	Pine oil		0.8
Non-coking bituminous, run-of-mine	Carbonado, Wash.	9.50	7.33	52.0	Pine oil		0.8
Coking bituminous, run-of-mine	Carbonado, Wash.	8.02	4.38	64.2	Pine oil		0.8
Semi-anthracite, run-of-mine	Carbonado, Wash.	14.38	10.73	60.0	Pine oil		0.5
Coking bituminous, run-of-mine	Wilkeson, Wash.	18.50	16.10	66.8	Pine oil		0.4
Coke (beehive)	Wilkeson, Wash.	23.65	18.00	60.8	Pine oil		1.0
Coke (beehive)	Fairfax, Wash.						

to float coal and are not nearly as good as might be obtained with better and more closely controlled conditions. Many of them show high-ash froths due to excessive use of the oils which float the bone with the cleaner coal. Very few of them were carried out with the idea of making a high recovery of combustible matter, but rather an attempt was made to produce clean concentrate. Frequently a test was stopped after only a small portion of the coal had been floated.

All the work represented in Table I was done in an ordinary Minerals Separation type flotation machine. The opinion was formed that this machine was not well adapted to the froth flotation of coal, as it seemed to require the addition of too much oil to the pulp. Later work in a Ruth machine, which corresponds to a sub-aerated Minerals Separation machine, proved this to be true, as much less oil could be used in the Ruth machine in order to get a satisfactory loaded froth.

Sample	Per Cent Ash	
	Feed	Concentrate
Total	22.65	17.14
Pass 60 mesh, held on 200 mesh	21.57	15.63
Pass 200 mesh	25.20	19.32

The coal seems to absorb the excess of oil from the water so that the frothing properties of the water are soon spoiled. Incidentally the fine coal seems to become overoiled and to form a dirty froth. This is illustrated by a screen analysis made on the feed and the concentrate of one of the tests with Bellingham sub-bituminous coal, which are given in Table II.

*Thomas Fraser and H. F. Yancey, *Reports of Investigations*, Bureau of Mines, Serial 2281, September, 1921.

cleanest being floated first, are given in Table III, which deals with two sub-bituminous coals, two non-coking bituminous coals and one coking coal. The first four were quite bony and the last was fairly clean without so much bone.

There seems to be no doubt that many coals can be considerably improved by froth flotation, though the bony coals are quite refractory toward the process. Assuming that there is a demand for it, some clean coal can undoubtedly be extracted from nearly all coals by utilizing the above-mentioned selective tendency to float clean coal first. This being true, the next real problem is the commercial disposal of the finely divided froth concentrate. It must first be dewatered, and this is no easy problem. With the relatively coarse material produced by the Minerals Separation work in England, a satisfactory result seems to have been obtained by using a Dorr thickener followed by an Oliver filter to bring the moisture content down to 10 per cent. However, there are few coals in the United States as clean as the coals experimented with in England and finer grinding than 10 mesh will doubtless be necessary in order to liberate more of the ash. This will give a product which will not settle so readily nor filter so easily. After a filter cake of the consistency of thick mud is discharged from the revolving filter, there is a serious question as to what to do with it.

DISPOSAL OF THE CONCENTRATE

Various proposals for the disposal of this concentrate are to be considered. One is to dry it out sufficiently to be used for powdered coal combustion appliances. Probably it would have to be ground somewhat further, or at least the lumps would have to be disintegrated,

so a regular coal-pulverizing machine would still be necessary, although it would have a very high capacity.

Another proposal would be to briquet the material and burn it in that form. W. Broadbridge, one of the Minerals Separation engineers, has secured a British patent¹ for this proposal in which he states that it can be briquetted by the use of 7 per cent of pitch or 5 per cent of pitch mixed with some cresol and kerosene. These percentages are calculated on the dry weight of the coal. The binder may be introduced into the froth concentrate in the liquid state or may even be used to produce the flotation and simultaneously provide the binding medium. Our results show that if enough oil to bind the material into briquets is introduced into the flotation pulp it will probably cause the non-selective flotation of all bituminous matter, leaving only the pure ash in the residue. This method could therefore be used to advantage only on coals containing no bony matter.

Still another proposal is to prepare the froth concentrate for the coke oven by dewatering as was done at the Skinningrove Iron Co. plant, except that with finely ground material or even with the 10-mesh material handled in that plant there is still too much moisture in the filter cake. It is probable that a partial drying of the filter cake in a rotary drier would be sufficient. At a certain critical percentage of moisture any mud or finely divided damp material will roll up into little balls when tumbled about in a machine like the rotary kiln drier. These little balls should make good material for feeding to a coke oven, as they would leave enough space between them to provide gas passages for escape of the coke-oven gas and avoid the "vomiting" which sometimes occurs with a closely packed, finely divided charge.

SUMMARY AND CONCLUSIONS

The work of the writers on a series of coals of the Pacific Northwest, most of them bony, taken in conjunction with the reports of the work of Minerals Separation, Ltd., in England, seems to justify the following conclusions about the applicability of froth flotation to the cleaning of coals:

(1) Due to unexplained difficulties, very finely ground coal slime does not concentrate well by flotation and the process is limited to the treatment of the more granular material. Whereas the finer sizes should give a cleaner concentrate, they actually give a dirtier one.

(2) Coals with a bright luster have been found to concentrate more cleanly than dull coals.

(3) There are indications that cleaner flotation is obtained when the coal is broken into sharp angular fragments than when ground down to rounded pieces.

(4) While in general the coals of higher rank, like the semi-anthracite and the coking coals, are more amenable to flotation, this is not essentially so, as some of the sub-bituminous coals have been successfully floated.

(5) The mode of occurrence of the ash in the coal is most highly important, as it has been found that most of the ash present in bony coal and bone coal cannot be liberated by the finest attainable commercial grinding.

(6) The free clean ash can be left in the flotation tailing and the remainder of the coal can easily be floated away from it.

(7) The cleanest coal is the most easily floated, providing the flotation oil consists of a poor frother

with no collector and a sub-aeration or pneumatic flotation machine is used.

(8) Bone coal floats almost as easily as clean coal, but will require the use of a better frothing oil and some collector for complete extraction.

(9) Bituminous shale is somewhat less easily floated than bone coal.

(10) For grading a coal by flotation into clean coal, bone, bituminous shale and free ash, careful control and the use of differential flotation methods is necessary.

(11) Flotation tests on removing the ash from finely ground coke have not shown much success.

Investigations of Iron Blast-Furnace Operation

The blast-furnace research section of the Bureau of Mines, located at Minneapolis, Minn., has carried out plant investigations for 6 years; these are being continued. The conviction has been forced on it, however, that little progress toward the solution of the many important problems involved in furnace operation will, or can, be solved by any method of study of commercial operations on account of the large amount of materials to be handled in these operations and the numerous causes of irregularities. The need of a furnace capable of operating on a small scale and under controllable conditions has been obvious for years. In the last year an experimental stack has been erected and twelve combinations of furnace lines and operating conditions have been tried out. This work is being continued.

The blast furnace works on the countercurrent principle; the ascending gas stream encountering the descending raw materials, with a regenerative transfer of heat. Maximum contact between gas stream and raw materials produces most rapid heat transfer and reduction of the ore. The degree of contact between gas stream and solid charge depends to a very large extent upon the size and shape of the furnace, and the investigation is planned with a view of acquiring data which will enable the engineer to design the furnace more rationally.

Another investigation relates to the effect of physical characteristics of the charge on blast-furnace operation. Probably the greatest cause of the fundamental inefficiency of the blast furnace considered thermally as a furnace is due to the enormous disparity between the sizes of the particles of the solids charged. In a number of cases furnace operators have improved furnace efficiency by sizing the coke charge. There are prospects of being able to continue such work on the sizing, not only of the coke but of the ore.

A laboratory study of the time rate of reduction of iron oxides by carbon monoxide is under way. The reducing gas employed will be 35 per cent CO and 65 per cent N₂. The iron oxide will be obtained from the higher grade Lake Superior shipping ores and the reducing gas will be driven through the ore bed at such rates of speed as obtained in blast-furnace operation—i.e., about 25 ft. a second. The rate of the reaction is known to depend primarily upon the gas velocity and the size of the ore particles. To a lesser extent the reaction will depend upon the temperature and the composition of the reducing gas.

Former investigations have been confined to a study of the reactions between iron oxides and carbon oxides, undiluted by nitrogen. The new work will therefore more nearly approximate furnace conditions.

¹Br. Pat. 155,875, Aug. 26, 1919.

Notes on the Manufacture of High-Speed and Tungsten Steels

Massive Carbides Were Separated From High-Speed Steel, Analyzed, and Found to Approximate the Composition of the Ferrotungsten Used in Their Manufacture—Structural Disposition of These Carbides After Various Heat-Treatments, With or Without Previous Mechanical Work

By J. W. WEITZENKORN

Vice-President and General Manager, Molybdenum Corporation of America

IN THE following the writer traces the steps taken in studying segregation in high-speed and tungsten steel. Valuable information is thus developed which may enable the steelmaker to eliminate some of the troubles in manufacturing tungsten steels and to produce a better product.

FERROTUNGSTEN BETTER THAN METAL

In the making of high-speed and tungsten steels tungsten is introduced either as ferrotungsten or as so-called metallic tungsten powder. It seems more logical to use the ferro-alloy; through its use not only will the final product be superior, but also many of the difficulties which are met in the production of tungsten steels can be eliminated.

The temperature of the average crucible furnace is from 2,900 to 3,100 deg. F., that of the electric furnace somewhat higher. The melting point of pure tungsten is about 6,400 deg. F. On the other hand, a ferro containing about 75 per cent tungsten melts in the neighborhood of 3,700 deg. F.; as the iron content increases, the melting point decreases, and the carbon content has a similar though less marked effect.

Due to the very high melting point of even commercial tungsten metal, it is necessary to observe certain precautions in smelting in order to prevent the tungsten metal, which alloys but slowly with the iron, from segregating, particularly in crucible practice. This segregation is sometimes so extensive that a button forms in the shape of a pancake in the bottom of the crucible. This button has always been found to carry a high percentage of tungsten and possesses a melting point higher than that of the steel, with the result that it was not sufficiently fluid to pour from the pot with the rest of the contents. The composition of one such button was C 0.83, Si 0.73, Cr 11.57, W 57.10, and Fe 31.07. The desired composition of the steel being melted was C 0.5 to 0.6, Mn 0.2 to 0.3, Cr 4.0 to 5.0 and W 20.0. In this instance the tungsten metal, as it settled to the bottom of the crucible in the course of the melting process, absorbed some of the ferrochromium of the charge; hence the high percentage of chromium.

This segregation is usually prevented in crucible practice in one of three ways:

First, the tungsten is added shortly before teeming.

Second, tungsten is distributed through the upper part of the charge, so that as the iron melts, the tungsten, on account of its greater specific gravity, passes down through the melt, giving it a chance to be alloyed with the iron by the time it reaches the bottom of the crucible.

Third, an agitation or boiling is produced, either by placing oxides at the bottom of the crucible or introducing oxides during the course of the melt, which tends to hasten the absorption of the tungsten.

The first method is not readily carried out and is considered impracticable by the greater number of steel-makers. The second procedure does not entirely prevent segregation when the tungsten is introduced as metallic powder, on account of its high melting point and slow alloying property. The third method is more widely used, but it is generally accepted that oxides are injurious to fine steel and every effort is bent toward their removal. Their introduction, therefore, would seem to be a step in the wrong direction, for it is very likely that the oxides are not completely removed by the subsequent melting and deoxidizing. Furthermore chromium, one of the essential constituents of high-speed steel, is readily oxidized. When combined with the oxide of iron, it forms one of the most highly refractory and inert combinations, one exceedingly difficult to eliminate when once formed, and when retained produces steel which can be forged with difficulty, and is likely to be brittle and probably crack during hardening.

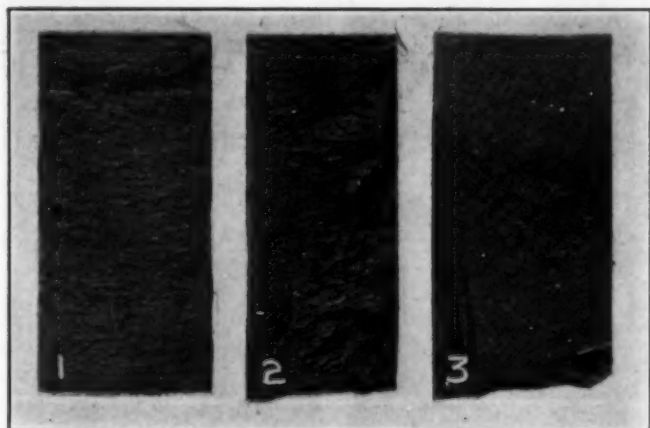
Ferrotungsten, on the other hand, readily alloys with the steel. As noted above, its melting point is much lower than metallic tungsten and likewise its specific gravity. Furthermore the tungsten, iron and carbon in ferrotungsten are already alloyed in somewhat similar chemical combinations and physical constituents to those existing in high-speed steel. The striking similarity which exists between the composite carbides found in high-speed steel and ferrotungsten will be apparent from what follows.

C. Mennicke, who compiled a most interesting and complete study of tungsten, in his book "Metallurgie des Wolframs" states that "the use of ferrotungsten in the manufacture of tungsten steels is beyond doubt superior, easier to handle and more effective than metallic tungsten." To this the writer would add that if the ferrotungsten is broken or crushed to the size of rice or of pea, it is in that condition readily handled in the mixing room and produces a cleaner, more homogeneous product, freer from segregation, oxides, slag and such foreign inclosures. In fact, the use of metallic tungsten is based on no logical conclusions, and experience shows a marked tendency toward the use of lower melting and easier combining tungsten alloys until now but few steelmakers have continued the older practice of using metallic tungsten.

INGOTISM

Occasionally small sections but more frequently large ones exhibit a dull, fibrous or woody fracture, both in the annealed and hardened state (Figs. 1 and 2), instead of the characteristic fine, porcelanic fracture of normal high-speed steel shown in Fig. 3.

Microscopic examination of sections showing this fibrous condition indicates that it is caused by a eutecti-



FIGS. 1 TO 3—FRACTURES OF HIGH-SPEED STEEL. ABOUT TWICE SIZE.

Fig. 1—Defective steel, hardened. Dull and fibrous fracture.
Fig. 2—Defective steel, annealed. Dull and fibrous fracture.
Fig. 3—Good steel, annealed. Fine, porcelainic fracture.

form segregation of carbides, which forms during the solidification of the molten steel. For convenience this structure will be referred to as "ingotism," from its nature and origin.

When "ingotism" is noted to a very marked degree in high-speed steel it causes the steel to be difficult to anneal, to possess hard and soft spots after annealing, to possess a coarse fibrous fracture in the annealed and hardened condition, to tear and show bright streaks upon machining, to be somewhat "brittle" or short, even in the annealed condition, to develop cracks in hardening which tend to follow the segregated carbides, to lower cutting efficiency, and to interfere slightly with secondary hardening, that characteristic increase in hardness on drawing hardened tools to about 1,000 to 1,100 deg. F.

In the ingot condition segregated carbides assume a "pine" or "fern-leaf" formation, which can often be

In large ingots, where the segregation is more marked on account of its slower rate of cooling, it requires a reduction of about 90 per cent in section area to break up this structure. Furthermore it was frequently noted in bars made from large ingots (10, 12 or 15 in. octagon) that the outside of such bars are almost completely refined, due to that portion having received a comparatively large amount of hot work, whereas the centers, which received less work, show less refinement.

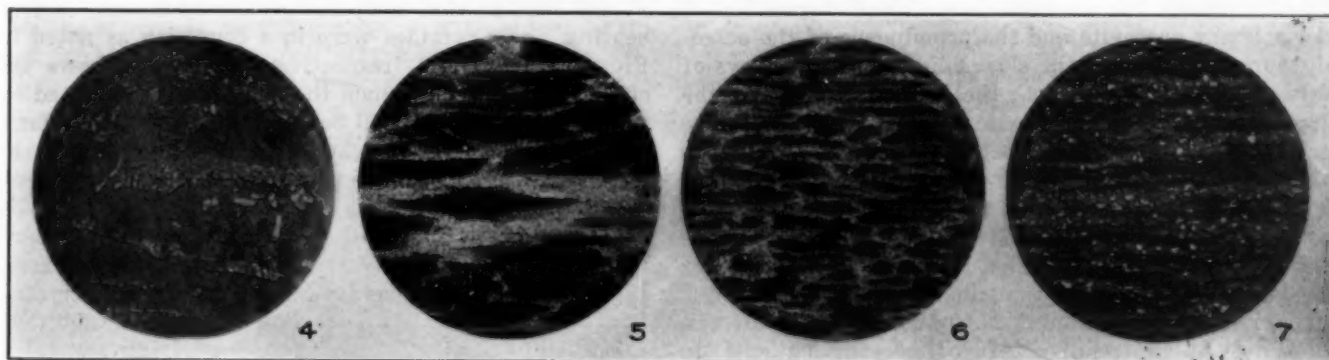
When starting with smaller size ingots, such as 4-in. octagon, the fern-leaf segregation is not as marked, due to more rapid cooling, and is therefore more easily broken up by forging and may be entirely eliminated upon reducing the section to 65 to 75 per cent. Sometimes it may be done with a very small amount of work, depending, however, on whether segregation was suppressed by the casting conditions; high casting temperature and slow cooling favoring "ingotism."

MECHANISM OF SOLIDIFICATION

As noted by the writer, the origin of these segregations of carbides in high-speed steel with very few exceptions can be traced to eutectiform masses and their position and formation attributed to "ingotism." It is difficult if not commercially impossible to prevent entirely the phenomenon in large ingots used to make the larger sizes of high-speed steel bars, and for this reason large bars do not show as refined a fracture nor as good as a microstructure as smaller sizes of the same chemical composition and heat-treatment.

Heating to about 2,200 deg. F. and holding a sufficient length of time to permit an absorption, solution or combination of these carbides, followed by an annealing, reduces the segregation somewhat, bringing about a more uniform condition, although it cannot be entirely eliminated by this method alone, nor by hardening alone from high temperatures.

A study of the casting condition of high-speed steel in ingots of various sizes seems to indicate that this



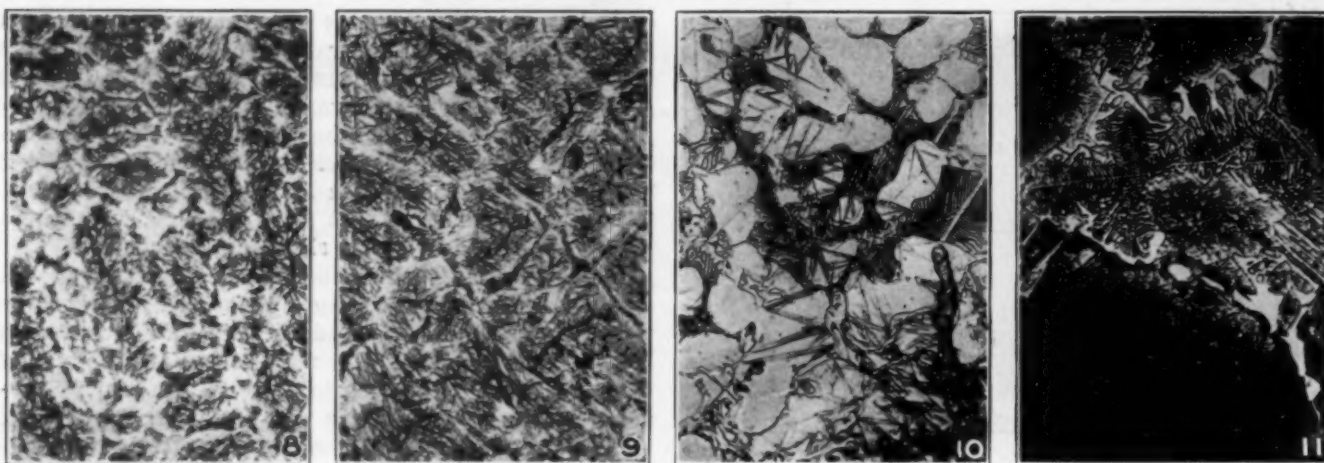
FIGS. 4 TO 7—SCATTERING OF SEGREGATED CARBIDE BY FORGING. $\times 165$

Fig. 4—Reduction 30 per cent. Fig. 5—Reduction 55 per cent. Fig. 6—Reduction 75 per cent. Fig. 7—Reduction 93 per cent.

noted in large-size commercial bars and frequently traced in smaller sizes, depending upon the amount of work that the steel received. Mechanical work and heat break up the segregations, as is shown in the series of microphotographs, Figs. 4 to 7 inclusive. A 15-in. octagon billet was forged (at a temperature of 1,900 to 2,000 deg. F.) into billet, bar and rod, microscopic studies being made at intervals. Fracture of a piece with structure like Fig. 4 was coarse and fibrous. Fig. 7 shows the retention of only a "ghost" of the original ingotism, and in the annealed and hardened condition should show a fine porcelainic fracture.

¹All sections were etched with 10 per cent HNO_3 in alcohol.

"ingotism" is favored by and is largely dependent upon the casting temperature and rate of cooling. In order to show the effect of various rates of cooling upon "ingotism" formation, a portion of a 100-lb. pot or crucible of molten high-speed steel was poured into cold water, thereby producing very rapid solidification; this will be referred to as condition No. 1. Another portion was teemed into a 4 x 4-in. warm mold, the rate of cooling being less rapid, and this condition will be referred to as No. 2. The crucible, with the remainder of the steel still in a molten condition, was put back into the furnace and the gas turned off, thereby permitting it to cool slowly with the furnace. After it reached a



FIGS. 8 TO 11—INFLUENCE OF COOLING RATE ON AMOUNT AND DEFINITION OF EUTECTIC. $\times 275$
 Fig. 8—Poured into water. Fig. 9—Poured into warm mold. Fig. 10—Quenched from pasty state. Fig. 11—Furnace cooled.

pasty condition (which required about 1 hour) some of the steel was removed and quenched in water; this will be referred to as condition No. 3. The remaining portion was permitted to solidify in the crucible, condition No. 4. It remained in a spongy or mushy state for about $1\frac{1}{2}$ hours.²

In the condition of sample No. 1, which was quenched in water from the molten state, one will note in Fig. 8 the comparatively small size of the eutectic as compared with the primary austenitic islands. The writer believes that these islands formed first and were enlarged by the effect of undercooling. This will also be noted in Fig. 9, representing the condition of sample No. 2, but here the effect of undercooling was not as marked, therefore the eutectic is more pronounced. Such "ingotism" as exhibited in these samples is readily broken up by the forging operations.

Fig. 10, which represents the condition after permitting the steel to cool slowly to a pasty state (condition No. 3), shows the characteristic island formation of the primary austenite and the prominence of the eutectic, normally noted in the slow solidification of alloys of this nature. One will note the increase in size of the areas occupied by the eutectic and the decrease of the primary austenite as the steel passes through the rates of cooling represented by conditions 1, 2 and 3. In the latter the eutectic has more freedom to grow its characteristic star- or leaf-like structure.

Fig. 11 represents condition No. 4, when the steel was allowed to solidify in the crucible, it being in a spongy state for about $1\frac{1}{2}$ hours. No undercooling is in evidence, and the relative proportions of eutectic to primary austenite can probably be considered as normal for very slow solidification.³

The above experimental tests agree with the numerous commercial tests on ingots of various size and indicate that the rate of solidification plays an important part as to the prominence of "ingotism." In fact, it seems to play the largest part in crucible practice, although the

initial casting temperature has a small influence for the following reasons: In order to cast the average high-speed steel successfully, the temperature should not be lower than about 2,800 deg. F., in fact, good steel is seldom poured cooler than 2,850 and various heats will average about 2,900 deg. F. The maximum temperature of large crucible furnaces is approximately 3,100 deg. F., but normally not over 3,000. Therefore the range for commercial casting does not extend much beyond 100 deg. F. and hence the initial casting temperature appears to play only a small part in the formation of "ingotism" in crucible steels. However, in the electric furnace, where higher temperatures are readily obtainable, the initial casting temperatures would have greater influence.

In order to show the effect of heat alone in breaking up this segregated condition, a sample of steel in condition No. 2 (cast in warm mold) and another in condition No. 4 (furnace cooled), as cast, was heated to 2,200 deg. F. and held at that temperature for 24 hours. Before heating, their carbides were in a condition as noted in Fig. 9 and Fig. 11, respectively. Fig. 12 shows the effect of this heating upon the condition represented by sample No. 2, and it will be noted that the eutectiform masses are entirely broken up. Such a degree of "ingotism" would have broken up more readily were this heating accomplished by mechanical work, but this experiment shows the ease of breaking up "ingotism" in the average small ingot. It will also be noted from Fig. 12 that the carbides tend to assume marked crystal-



FIG. 12—SAMPLE SHOWN IN FIG. 9 AFTER HEATING AT 2,200 DEG. F. FOR 24 HOURS. $\times 200$

line forms, especially those not lying along the border of a grain, but apparently thrown out of solution from the primary austenite. That the eutectiform carbides have great freedom when heated to a temperature such as 2,200 deg. F. can be noted by comparing the change in form from that of the ingot condition shown in Fig. 11 to what may be termed an equilibrium state as shown to the right end of Fig. 13. This figure rep-

²In order to appreciate fully the process of solidification of high-speed steel and the formation of these carbide segregations, as well as the causes of these characteristic eutectiform masses, the reader should refer to Dr. Henry M. Howe's work on the "Metallography of Steel and Cast Iron," 1916, pages beginning 135, which describe the solidification of pure and eutectiferous alloys, and page 210 for the effect of "undercooling."

³The samples represented by Fig. 11 were etched in 10 per cent nitric acid rather heavily in order to show a marked contrast between the eutectic and primary austenite. It was noted during etching that the primary austenite was readily attacked by this method, and it was used as will be referred to later, in an endeavor to separate the eutectic as a "sponge" from the matrix or austenite.

resents the course which these eutectiform carbides follow upon being broken up by heat alone.

Since the photomicrographs showing these stages were all taken from one sample and assembled into a composite view, it may be noted that heating to a high temperature breaks up these eutectiform carbide masses in several stages.

Some films and masses break up sooner than others, probably depending upon the carbide saturation of the surrounding matrix. The writer believes that the first change from the ingot condition is the formation of a eutectiform mass with thin sheets of carbide and austenite alternating, shown on the left end of Fig. 13. The sheets, or arms or ribs whatever they may be called, next dissociate to form spheroidal masses, as shown near the center of the illustration. These then agglomerate to form carbide masses or islands, shown to the right of Fig. 13. It may furthermore be remarked that higher magnifications reveal small isolated crystallites occurring within the original austenitic crystals, exhibiting plane boundaries and angular edges, similar to those noted above and shown in Fig. 12.

EFFECT OF OVERHEATING

That the eutectiform masses, which are broken up during the combination of heat and mechanical work in commercial manufacture, are of low melting point and are the structures to which the carbides, found in normal high-speed steel, revert upon heating a bar to the point of fusion can be noted from Fig. 14. If a bar of normal high-speed steel, exhibiting the structure shown in Fig. 7, be heated to a temperature just under the fusion point and quenched in oil, the structure at 600 diameters shows fairly large austenitic grains, and in the interstices sizable masses of well-developed and clearly laminated eutectic. The "fern-leaf" carbide formations develop in steps similar to those noted in the breaking up of "ingotism" by heat alone, but vice versa. The carbide masses first appear to form spheroids, which in turn form arms of a eutectiform mass. However, the spheroidal carbides noted in Fig. 14 may have been the arms of a eutectiform mass that broke up during the subsequent slow cooling of the highly heated bar. Fig. 13 and Fig. 14 show striking similarity.

It was mentioned above that if the polished samples



FIG. 14—NORMAL HIGH-SPEED STEEL HEATED TO JUST UNDER FUSION, HELD AT THAT TEMPERATURE FOR SEVERAL HOURS AND COOLED SLOWLY. $\times 400$

of high-speed steel which were permitted to cool slowly with the furnace from the molten state (condition No. 4), the primary austenitic islands or masses were attacked readily during etching in 10 per cent nitric acid, whereas the network of eutectiform carbides were not affected. By the use of this method the following attempt was made to determine the chemical composition of the eutectiform carbides.

CHEMICAL ANALYSIS OF CARBIDES

Small pieces about $\frac{1}{8}$ in. square were ground and polished on one side, similar to preparing a sample for microscopic examination. This polished side was cut off the piece by means of a thin-friction carborundum wheel, giving a disk about $\frac{1}{16}$ in. thick. This disk was placed in a clamp with the polished side facing in. The opposite side was then ground and polished, reducing the thickness to about $\frac{1}{32}$ in. The disk was then weighed

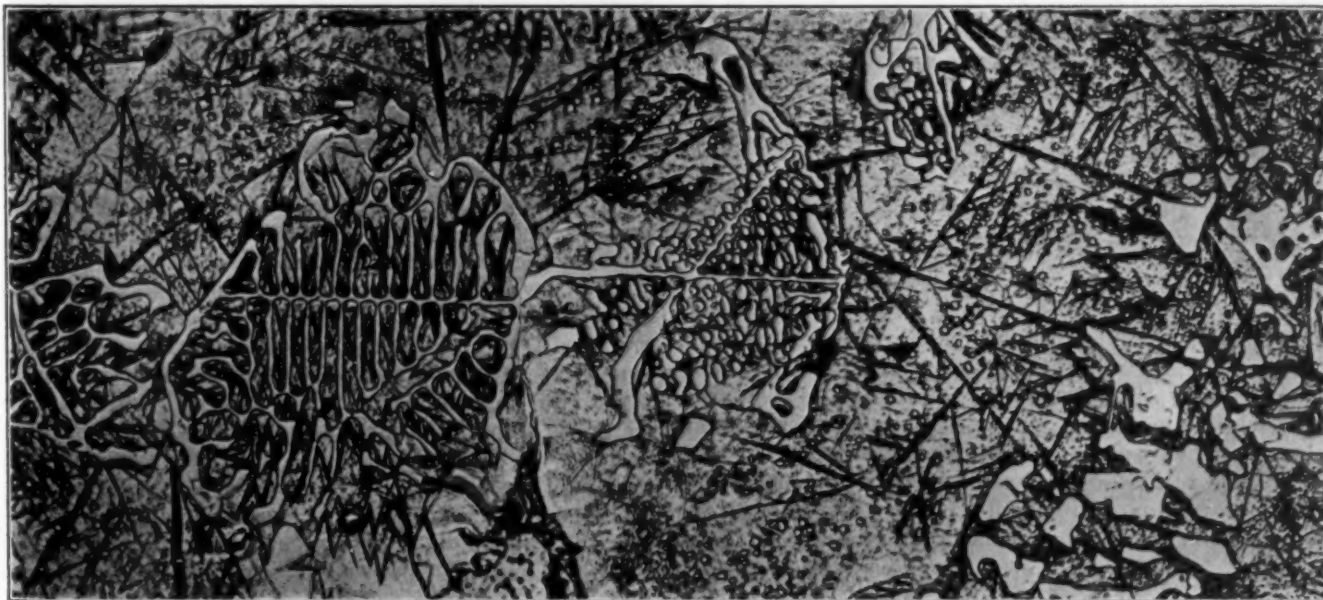


FIG. 13—COMPOSITE VIEW OF SAMPLE SHOWN IN FIG. 11 AFTER HEATING AT 2,200 DEG. F. FOR 24 HOURS. $\times 350$

and suspended by means of a platinum wire in a beaker containing 10 per cent nitric acid. After a period of about 240 hours all reaction appeared to end; it was dried, weighed and placed in fresh acid until no further reaction was noted and no loss of weight detected, after which it was analyzed. Results are shown in Table I.

The chemical composition of the original steel is as follows: C 1.34 per cent, Mn 0.34, P 0.020, Si 0.59, Cr 3.14, W 15.88, V 0.83.

It will be noted that the carbon content, 1.34 per cent, is much higher than is usually found in commercial high-speed steel. This was not made intentionally, but was due to the absorption of additional carbon from the crucible during the soaking and slow cooling.* Therefore the chemical composition obtained by the separation of the eutectiform carbides by the above-mentioned

content by difference, the approximate chemical formula of these eutectiform carbides is: $VCr_2W_{10}Fe_3C_3$, which figures C 3.10 per cent, W 55.90, Cr 3.31, V 1.52, Fe 36.17.

SUMMARY

1. The composition of the eutectiform carbides examined may be represented by the formula $VCr_2W_{10}Fe_3C_3$ and has the following chemical composition: Carbon 3.10 per cent, tungsten 55.90, chromium 3.31, vanadium 1.52, iron 36.17, and excepting for the chromium and vanadium content is the approximate composition of ferrotungsten. The composition of the primary austenite of the specimens examined appears to be: Carbon 0.77, chromium 3.10, vanadium 0.63, tungsten 3.71.

2. These eutectiform carbides are essential factors in imparting high-speed properties.

3. When present in eutectiform mass, these eutectiform carbides produce in high-speed steel a coarse, fibrous, woody fracture in the annealed, natural or hardened states.

4. The condition mentioned in item 3 causes the steel to be difficult to anneal, to possess hard and soft spots after annealing, to tear and show bright streaks on machining, to be brittle or short even in the annealed condition, to develop cracks in hardening and to lower the cutting efficiency.

5. The condition mentioned in item 3 is favored by high casting temperature and slow cooling, hence the advisability of using ferrotungsten with its lower melting point and easy solution in the melting mass of the charge, which form of tungsten favors lower temperatures, more rapid melting and quicker cooling.

6. The condition mentioned in item 3 can be broken up best by the combination of heat and sufficient mechanical work. It cannot be entirely removed by heat alone, nor eliminated by hardening and annealing.

Pittsburgh, Pa.

Scotch Producers Combine to Push Esparto Paper

An important combine recently organized in the Scottish paper-making industry is reported in the March 6 issue of *Commerce Reports*. The new organization is to be made up of the esparto paper mills of Scotland, including eight or ten mills. There is no intention to disturb the existing organizations, the mills to continue their own individuality and their own directing board. The propaganda and the advancing of the business throughout the world generally will be handled by the board, with the assistance of the present distributing houses, which are for the most part favorably disposed. It is hoped to develop a very big business in America.

The sole idea underlying the action of the promoters of the new combine is to extend the demand for the use of esparto paper so as to enable it to be more cheaply produced. Esparto grass, which is gathered in large quantities in Africa and to a smaller extent in Spain, is said to constitute one of the best of paper-making materials, especially for those qualities of paper used in printing papers, books and magazines, as well as the qualities used in lithographic printing and art work. It is claimed that its great peculiarity is that it will not stretch, is opaque, and light in weight. It is also stated that the only place in the world where this class of paper is made is in the British Isles, chiefly in Scotland.

TABLE I—INSOLUBLE CARBIDES FROM HIGH-SPEED STEEL

Sample No.	Wt. Disk, G.	Loss Wt., G.	Wt. Carbide Residue	Per Cent Loss Wt.	Per Cent C in Residue	Per Cent W in Residue	Per Cent V in Residue	Per Cent Cr in Residue
1	3.3778	2.5818	0.7960	76.4	3.49	52.9	.....	.....
2	1.7895	1.3987	0.3908	78.2	3.15	60.0	.....	.....
3	Destroyed							
4	0.7965	0.6169	0.1796	77.4	3.07	57.9	.....	.....
5	0.6961	0.5386	0.1575	77.4	3.18	58.9	.....	.....
6	Destroyed							
7	0.6544	0.5092	0.1452	77.8	3.79	58.5	.....	.....
8	1.7563	1.3535	0.4028	77.1	2.95	57.4	.....	.....
9	3.2844	2.5474	0.7370	77.4	.....	.....	1.52	3.31

method may not be of exactly the same composition as those usually found in high-speed steel containing about 0.50 to 0.70 per cent carbon. However, the analyses may give some idea of the approximate composition of these carbides and probably their real composition, if the elements tungsten and chromium form definite combination with carbon.

It will be noted that, although the weights of the polished disks show quite a wide variation, nevertheless the percentage of loss in weights is nearly constant, indicating that the extraction of the matrix from the sponge of carbides was practically uniform.

Table II shows the calculated composition (using the values given in Table I) of the primary austenite, or

TABLE II—SOLUBLE METAL FROM HIGH-SPEED STEEL								
Calculated composition of primary austenite or the areas that went into solution					Chemical analysis of solutions after removing carbides			
Sample No.	C	W	Cr	V	W	Cr	V	
1	0.68	4.46	.....	.....	4.15	.....	.....
2	0.83	3.54	.....	.....	3.29	.....	.....
4	0.83	3.67	.....	.....	.....	.....	.....
5	0.80	3.66	.....	.....	.....	.....	.....
7	0.64	3.73	.....	.....	.....	.....	.....
8	0.87	3.52	.....	.....	3.42	.....	.....
9	.....	.....	3.10	0.63	.....	3.03	0.74	
Av.	0.775	3.71	.....	.....	Av. 3.62	.....	.....

the masses that went into solution, together with results of chemical determinations of the tungsten, chromium and vanadium contents of the solutions. A comparatively close agreement exists between the calculated values and the results of actual determination.

Only one residue or separated eutectiform mass was used for chromium and vanadium determinations. However, by using the data on hand and obtaining the iron

*That such absorption took place is evident from the fact that samples 1 and 2, that were quenched in water and teemed into a mold, respectively, show only 0.87 per cent carbon, which, too, is slightly high.

Shaloilogy and Oil-Shale Nomenclature

A Consideration of Some of the Inconsistencies in Present Oil-Shale Terminology—As an Aid to the Definite Expression of Ideas in This Industry the Following Are Suggested: Petrologen; Petrolo-Shales; Oil-Shale; Petroil; Shalene; Shaloilogy

By J. B. JENSON

OUR American shales and the production of oil therefrom is at present being discussed in written articles by many writers of varying experience and capacity. Some of these are recording more or less valuable results of experimental and research work, some of which is new and some already well-known facts; others are merely rehashing old and well-worn data gleaned from the records of Scotch operations and U. S. Geological Survey Bulletins.

Those of the former class are endeavoring in an honest way to contribute their quota toward the pioneering of the coming shale-oil industry, an industry which cannot help but become sooner or later one of the largest and most important within the boundary of the United States. Owing to the fact that it is in its infancy in this country and its literature somewhat limited, and owing to the further fact that it has developed without elaboration from a sort of cut-and-try method to its highest scientific development in Scotland, the nomenclature of the industry is small and some of the terms adopted are not only unscientific, but are either meaningless or convey a meaning not intended. As the industry develops, new terms will of course eventually find their way into our shale-oil lexicon, but inasmuch as important data are already being recorded and will continue to be recorded as the scientific development of the industry progresses, it is important that meaningless terms be either eliminated or substituted as early as possible by scientific terms of correct meaning, in order that the nomenclature and development of the industry may be proportionately advanced and also that present-day articles of importance may contain terms which shall not soon become obsolete to the detriment of such articles.

BITUMINOUS SHALE, PYROBITUMEN AND KEROGEN

The term "bituminous shales" is one in common usage and quite correctly so, although the oil-making material in the shale cannot properly be termed "bitumen."¹

The term "pyrobitumen" has been applied to that substance in oil-yielding shales which is not soluble in carbon bisulphide but which when subjected to heat will become transformed into oil.

A somewhat more popular term, "kerogen," was very

properly suggested by Prof. Crumb Brown many years ago and has been used in Europe quite universally ever since, to denote "the carbonaceous matter" in Scotland's shales that gives rise to crude oil in distillation.²

At the time of its adoption the principal important product from Scotch shales was kerosene, and it is only natural that the term "kerogen," or "source of kerosene," should suggest itself to Prof. Brown. At the present stage of the world's development, however, kerosene as an oil product becomes of only minor importance and its source of little interest to us, while the matter to which the term is applied is of great interest and is very much more than the source of kerosene. It is the source of petroleum, the mother of kerosene and all the varied petroleum products and byproducts. If Prof. Brown had in mind to base the term on "kero" as wax, intending it to express "the source of wax or paraffine," it becomes perhaps even less appropriate. The term does not fully suggest to the mind or cover the matter referred to; it is not broad enough or deep enough and can scarcely be considered to be a satisfactory scientific and definite term, particularly when applied to our American shales, wherein the source of petroleum in its embryo condition and broadest sense is referred to.

Furthermore, our Eastern and our Western American shales, but not our Central Devonian shales, are geologically younger than the Scotch shales and their oil-making material has not reached that degree of decomposition that has been reached in the Scotch shales, giving us therefore in these not only a much different product but one compelling us also to do, in our retorts for these shales, what nature has partly done for the Scotch shales *in situ*. This to a certain extent accounts for "fluxing" and other troubles in the retorting of some of our high-grade massive shales of Utah and Colorado, and even though the term were applicable to Scotch shales, it does not follow that it is applicable to American shales.

"OIL-SHALE" A MISNOMER

The term "oil-shale," which suggests to the mind a shale containing oil, much as saturated sands do, is freely used not only to designate shales which do not contain oil except in mere traces but which do contain the carbonaceous material capable of producing oil, but also to designate such shales as do contain oil and from which it may be extracted, but which do not contain the material from which oil may be produced or manufactured.

We are rapidly approaching the stage of development wherein it becomes necessary to designate which class of shale is being referred to—the oil-producing shale,

¹Bitumen. "The substances which furnish oil or tar when subjected to dry distillation." ("Shale Oils and Tars," Scheithauer, p. 19.)

²"A generic term applied to native substances of variable colors, hardness and volatility, composed of hydrocarbon substances free from oxygenated bodies; sometimes associated with mineral matter, the non-mineral constituents being fusible and largely soluble in carbon disulphide. Examples: petroleum, native asphalts, native mineral waxes and asphaltites." ("Asphalts and Allied Substances," Abraham, p. 21.)

³"A naturally occurring hydrocarbon complex, often associated with a mineral matrix, insoluble in water, but largely soluble in carbon disulphide, benzol, etc. Its color and hardness are variable." ("American Petroleum Industry," vol. 2, p. 853.)

⁴"Shales of the Lothians," p. 143.

the oil-containing shale, or some of the intermediary shales between these.

By way of illustration: The black "warty" shale of the upper horizon in the Utah, Wyoming and Colorado fields yields only a trace of oil through solvents, but is capable of producing more than 70 gal. per ton by destructive distillation. There is no evidence of oil to the touch and none of the true petroleum odor, but on freshly breaking, the shale gives an odor peculiar to certain hydrocarbons. It contains virtually no oil, but is rich in oil-making materials.

The diatomaceous and other shales of California and similar fields contain a high percentage of oil but little or none of the oil-making material. They are oily to the touch and give forth a strong petroleum odor. Practically all of the oil in them may be extracted by solvents.

We have in the Uinta Basin an almost white or cream-colored shale which produces, through the agency of solvents, 7½ gal. of fine-grade paraffine oil; by destructive distillation 21½ gal. It therefore contains both oil-making material and free oil or possibly bitumen and in the proportion of about two to one. It is a hard, compact, dry, fine-grained shale having somewhat the appearance of a white limestone, will not soil the whitest silk handkerchief and gives absolutely no suggestion of oil, yet when ignited it burns freely and forms a ring of oil on the shale surrounding the flame, something which is not usual in other shales.

As the industry develops and the shale products come into competition with underground petroleum products, it will become necessary to designate which particular product is wanted—for instance, whether "shale gasoline" or "petroleum gasoline," if motor fuel is wanted. Terms designating this may also be used to very good advantage at this time in our research work.

RETORTING VS. CARBONIZATION OF SHALES

Occasionally someone speaks of the distillation of oil from shale as the "carbonizing of shale." Is it truly carbonizing shale?—i.e., "converting animal and vegetable matter into a residue of carbon by action of fire or corrosive agents."¹

Or is it "converting to carbon by the action of fire or an acid or by any other means," such as we do in carbonizing or converting coal to coke and in connection with which industry the term seems to have originated? We are not interested in converting the oil-making material of shale to carbon or coke, but into crude oil, capable of being successfully and commercially refined into marketable products. That is done by proper distillation in a suitable retort, "a vessel in which substances are subjected to distillation or decomposition by heat,"² either intermittently or continuously.

Shale differs from coal in having a larger proportion of hydrogen in its composition and in not leaving coke on distillation. When heated in an air-tight retort, the hydrogen unites with the carbon so as to carry it away as gas and the residue left is not coke or carbon but ash, with a very small portion of carbon—in fact, is simply a spent shale.³

It would seem then that the appropriate term for this operation is not "carbonizing," but either retort-

ing, "the act of distilling or decomposing the oil-making materials," or eduction, "the act of drawing out" the oil-making material as gases, from either oil-producing or oil-bearing shales.

PYROLYSIS VS. DESTRUCTIVE DISTILLATION

Another term which is not only cumbersome and unwieldy but in general quite distasteful is that of destructive distillation, a term which creates with the layman an undesirable impression, as was shown by a rural, bewhiskered "old timer" who, after listening to a paper read at one of our shale conventions, arose and said, "If you chemists and engineers would quit your 'destructive' distillation and do a little 'constructive' distillation, we would soon begin to get somewhere." Dr. W. A. Hamor, of the Mellon Institute, however, has very splendidly substituted "pyrolysis" for this term, and the new word is rapidly being adopted and already becoming quite extensively used by our chemists and engineers.

NEW TERMS SUGGESTED

To overcome some of the objections referred to and to express myself more definitely I adopted, 3 or 4 years ago, some terms of my own which I have used continuously ever since, particularly in my geological reports. They have been serving their purpose well and I thought little of them until recently I was favored by a visit from one of our active petroleum geologists who had observed these terms and who expressed himself as highly impressed with their importance. To quote his own words: "They are expressive and impressive. They are terms which grow on one, and continue to revolve through the mind for days after hearing them. Give them to the public and let geologists and chemists also have their use. We are just entering a nationally important industry and much is being done and much written on the subject. We need these and need them now."

From the thoughts developed by this conversation and with a desire to see not only the supremacy of American engineering and American chemistry maintained, but also, with the development of the industry, the simultaneous development of a concise, accurate and scientific American shale nomenclature, I have been prompted to present and discuss these matters. Therefore I submit, for the consideration and discussion of our American petroleum geologists and chemists, the terms which I am using and which apparently not only overcome the objections mentioned but also convey to the recipient a correct idea of what is intended.

In considering the adaptability of these terms, the first question which naturally arises is: Is the crude oil, produced by distillation of shale, a petroleum or sufficiently near such that it may come into the petroleum class? It is true that as at present produced it contains, on the average, a higher percentage of unsaturates than does most underground petroleum, but the unsaturates of petroleum from different fields also vary as widely as do some of the shale petroleum products when compared with some underground petroleum products.

We find also that the unsaturates of a single shale vary as widely when retorted by different methods as do those of some underground petroleum and some shale petroleum. Is it not likely, therefore, that as we shall more nearly approach the method of nature in the production of oil in our retorts, we shall more nearly

¹"Webster's Unabridged Dictionary."

²"Winston's Simplified Dictionary."

³"Webster's Unabridged Dictionary."

⁴"Shales of the Lothians," p. 160.

approach also and eventually perhaps duplicate the oil-well products?

Notwithstanding the existence of several theories as to the origin of petroleum, I believe it is quite generally conceded by our best petroleum geologists that the major portion of our underground petroleum is the result of underground distillation of oil-making materials similar to those of our exposed shales, if indeed they be not lower lying petroliferous shales of a similar nature. Even though we might accept the inorganic theory as the source of underground petroleum, might it not also apply to the source of the oil-making material in our shales? On fractionation and subsequent treatment, we find the shale oil yields practically the same products as the underground petroleum, the slight variation probably being due in part to the short time used by us in their production from the shale as compared with that employed by nature. It would seem therefore, in the adoption of our first term—the term indicating the oil-making material—that we are fully warranted in selecting one which carries with it a suggestion of petroleum.

PETROLOGEN

From the fact that the hydrogen and carbon, or oil-making material as contained in the shales, is the source of petroleum, I have taken from the word petroleum the first syllables "petrol" and have added the suffix "ogen," or source, to form the word "petrologen," indicating the source of petroleum, or that material which, through pyrolysis or destructive distillation, produces crude petroleum.

There are, as we know, a number of theories as to the origin of petrologen. The most important of these are the organic and sedimentary¹ and the inorganic² theories. Although it has not been positively established, it is reasonably certain that petrologen consists of plants, vegetable fiber, spores, algæ, etc., with smaller portions of animal matter, which were deposited at the bottom of lagoons and quiescent inland lakes, together with clays and ooze and which have been subjected under pressure, in the absence of atmospheric agents, to maceration and microbial action and have finally become a minutely disseminated but integral part of the shale strata, and which were apparently laid down during periods in Devonian, Carboniferous and early Tertiary times. The main constituents of our petrolo-shales are petrologen, iron pyrites and clay.

PETROLO-SHALES

To those shales which are still in their primary, unaltered condition containing petrologen but not petroleum, and therefore are yet only a source of petroleum, I apply the term "petrolo-shales." This applies in general to the shales of Colorado, Utah, Wyoming, New Brunswick, the Devonian shales of Kentucky, etc.

OIL-SHALES

To those which were originally petrolo-shales, but which, through later earth heat, have given up their petrologen and then through absorption have taken up the resultant petroleum and are now saturated or true oil-shales and to those shales which were originally not petrolo-shales, but which through capillary attraction

or otherwise have taken up migratory oils and therefore also contain oil, I retain the term "oil-shales."

PETROIL

Inasmuch as shale oil and underground petroleum resemble each other closely in source and characteristics and will shortly be converted into competitive products, it is desirable and highly important that we have for shale oil a term which not only suggests similarity and relationship to underground petroleum but which also maintains a marked distinction between the two products.

I have endeavored to accomplish this by the adoption of the Latin "petro" (rock) as in petroleum, and the substitution of our own word "oil" for the Latin term "oleum," obtaining thereby the very simple term "petroil," which has both the distinguishing feature and the correct meaning, "rock-oil." I am aware that this word is somewhat similar to the European term "petrol" but with the accent in one case on the first syllable and in the other on the last syllable, together with the very wide distinction between the application of the two words, this, it seems, should not be an important objection and the similarity is no greater than is the case in many other instances.

SHALENE

To distinguish the product from "petroil" which corresponds to the gasoline fraction from petroleum, I add to the word "shale" the letters "ne" to form the word "shalene."

SHALOLOGY

To indicate the science relating to the oil-making materials, oil-bearing and oil-producing shales, rocks, etc., as well as the products derived therefrom, their extraction or production, I combine the word shale, after having dropped the final "e," with the letters "oi" from oil and add the combining term "logy" to form the word "shalology."

SUMMARY

The concise terms thus developed may be summarized and defined as follows:

Petrologen.—A bituminous substance contained in petrolo-shales, coal, peat and other materials, which when subjected to pyrolysis in the absence of air produces a crude form of petroleum termed petroil; a sedimentary yellowish gray or brownish substance, being the remains of innumerable minute accretions and accumulations of vegetable fiber, algæ, spores, etc., frequently with small proportions of marine animal remains, originally deposited under water on the bottom of lakes and lagoons in Devonian, Carboniferous and Tertiary times and subjected to pressure, maceration and microbial action free from atmospheric conditions and being preserved, compressed into and becoming an integral part of the clay strata forming our present-day petrolo-shales.

Petrolo-Shales.—When pure, a fine-grained, gritless, argillaceous, sedimentary, underwater deposit, ranging in thickness from a fraction of an inch to many feet, containing petrologen and disseminated iron pyrites usually of microscopical fineness; that class of bituminous shale which is still in its primary unaltered, unretorted, unmetamorphosed condition and therefore contains petrologen but not petroleum or petroil, but

¹"The New Oil-Shales Industry of the Western Slope," by the author, p. 2.

²"Kerosene Oil-Shales," by Kärne, p. 64.

which when subjected to pyrolysis in a closed retort or otherwise in the absence of air is capable of yielding petrol. Impurities are lime and quartz, with petrogen decreasing proportionately as these impurities increase.

Oil-Shale.—An argillaceous or diatomaceous, porous, laminated or massive sedimentary or other mineral accumulation containing, through absorption or capillary attraction, petroleum, bitumen or other residual petroleum, resulting either from formerly contained petrogen or migratory petroleum and from which petrol may be extracted through the agency of solvents or by simple distillation but not requiring pyrolysis.

Petrol.—A term used in contradistinction to the term "petroleum" as applied to free-flowing underground petroleum obtained naturally from oil wells, and designating a crude petroleum obtained through the pyrolysis of petrogen, pyrobitumen or oil-making matter contained in petrolo-shales, peat, coal, etc., and capable of being fractionated and refined into products quite similar to those of petroleum. The product obtained through digestion by solvents, distillation or pyrolysis of the oil, bitumen or other oil-yielding materials in such substances as oil-shales, oil-sands, etc.

Shalene.—That fraction distilled from petrol which corresponds to the "gasoline" or "motor spirit" fraction distilled from underground petroleum.

Shalology.—The science which treats of the nature and formation of the crude materials found in nature, such as petrolo-shales, oil-shales, oil-sands, peat and other bituminous matter or materials, from which petrol may be either extracted or produced through the agency of solvents, distillation or pyrolysis. The science which treats of the digestion treatment by solvents, distilling or retorting of bituminous or petroliiferous materials in the production of petrol and all its varied products and byproducts.

Salt Lake City, Utah.

The Oil Industry in Russia Under Bolshevik Régime

All available data indicate that the exploitation of the Baku region as a whole has not nearly reached its full scope of development, according to an article appearing in *Commerce Reports* of Jan. 9, 1922. Only the upper horizons have thus far been worked, while the richer deposits contained in the lower strata are yet to be tapped.

The production of oil in Russia is distributed very unevenly among the principal regions of Baku and Grozny in the Caucasus and the secondary areas in the Emba region of the Urals—Turkestan, Maikop, Vosnesenk and Tshelen. The four principal fields of the Baku region—Balakhna, Sabunchi, Romany and B. B. Eybat—cover an area of 2,978 acres. The newer fields of Surahany, Benagady, Atashka, Holy Island, etc., cover a far more extensive area, not so far fully delimited by geological surveys.

The total production of the Baku region in the last pre-war year (1913) amounted to 7,532,000 tons, or an average of about 628,000 tons per month. Its productivity for the three pre-Bolshevik years were: 1914, 6,840,300 tons; 1915, 7,267,700 tons; 1916, 7,691,900 tons.

For the period March to July, 1918—i.e., for the period of the first Bolshevik occupancy of the region—the production averaged 279,000 tons, as against the

monthly average of 440,000 tons for the first 2 months of the same year.

During August and the first half of September the Baku region was controlled by a new government—namely, the "Dictatorship of the Central Committee of the Caspian Naval Fleet." Under the "dictatorship" the output was, in August, 181,000 tons, and from Sept. 1 to 15, 92,000 tons. After Sept. 15 production stopped completely and the properties were ransacked and burned, a large number of the workmen being killed. On Oct. 10 the oil industry was denationalized by the Azerbaijan Government, which occupied the Baku region with the aid of the Turks, and the properties were restored to their former owners. The owners proceeded with the task of rehabilitating the industry. They managed to get up a production of 150,000 to 160,000 tons per month for October, November and December, 1918, and an average of 300,000 tons per month for the year 1919. This average was maintained up to April 27, 1920, when Baku was occupied, for the second time, by Bolshevik forces, and on May 28 the oil industry was again nationalized. At that time the oil industry of Baku had about recuperated, after 20 months of continuous private exploitation, from the violent perturbations of 1917-18. From that point (May 28, 1920), however, production declined steadily, the average monthly production for the first 10 months of 1921 being 205,200 tons.

There are 7,000 men employed in the fields, and for the first half of 1921 this force was augmented by 4,000 Red Army laborers. In 1916 the monthly productivity per employee, exclusive of distilleries, averaged 234 tons, which compares with 80 tons at the present time. The drilling average in 1916 was about 105 ft. per month per employee, as against 28 ft. at present. The same ratio obtains in the case of the distilleries and refineries.

The grand totals of the output of oil for the first 6 months of 1921 covering all the oil fields of European Russia, as compared with the figures for 1915 and 1920, are shown in the following table:

Month	1915 Tons	1920 Tons	1921 Tons
January.....	797,000	340,000	277,000
February.....	716,000	306,000	289,000
March.....	797,000	347,000	335,000
April.....	765,000	305,000	339,000
May.....	805,000	305,000	373,000
June.....	761,000	397,000	363,000

Cadmium Production for 1921

Figures obtained from producers by the United States Geological Survey show that the total production of metallic cadmium in 1921 was 65,101 lb., a decrease of 64,182 lb., or about 50 per cent, as compared with the production in 1920. On the other hand, the production of cadmium sulphide in 1921 amounted to 65,446 lb., an increase of 33,313 lb., or more than 100 per cent, over the production in 1920.

The value of the metallic cadmium produced was \$63,799 and that of the cadmium sulphide was \$71,336, making a total value of \$135,135, as compared with \$188,535 in 1920, a loss of 28 per cent. The average selling price of metallic cadmium in 1921 was 98c. a pound, as against \$1.17 in 1920, and that of cadmium sulphide was \$1.09 a pound, as against an average price of \$1.16 in 1920.

A noteworthy development of the year was the extension of the use of cadmium electroplating for preventing rust.

A Neglected Electromagnetic Force

BY CARL HERING

IN your issue of January, 1913, p. 48, Dr. E. F. Northrup described a curious and interesting phenomenon: a kite-shaped piece of copper (well amalgamated) was floated on a trough of mercury so that its small end pointed toward one end of the trough, and its round or large end pointed toward the other end; it was found that when a very large direct current was passed through the mercury, the copper piece moved lengthwise to the trough, large end foremost; its direction of motion was independent of the direction of the current. The explanation offered by him was that the pinch effect (the radial contraction of the conductor) was greater at the smaller than at the larger end; copper having a very much better conductivity than mercury, the current was shunted largely through the copper.

In the opinion of the writer the true or primary cause of the motion is a different one, and as such new and peculiar forces may perhaps sometimes be made good use of in electric furnaces, a search for their origin and properties may be of interest, so that they may be correctly and intelligently applied.

RESULTS OF EXPERIMENTS

Believing that this force was not primarily due to the pinch effect, whose force is perpendicular to the direction of the current and could therefore produce a longitudinal force only by hydraulic action, the writer floated a thick, kite-shaped piece of copper on a large circular bath of mercury about as shown in the adjoining diagram, the current being passed through the bath between the two terminals shown.

When a large direct current was used from storage batteries the copper piece made a decided but very short momentary movement toward the other pole the instant when the current was started, but the motion soon ceased; it was a mere "kick." The pinch effect was apparently very small, though if it had been the cause the motion should have continued and should not have been merely an impulse or kick.

The writer's proposed explanation is that because the magnetic flux encircling the main path of the current near the small end was more dense than that around the main path at the large end (as indicated very crudely by the dots which are supposed to represent the cross-sections of the center lines of unit lines of force) the well-known lateral repulsion of like lines of force (therefore longitudinal with the path of the current) was greater at the small end than at the large one; it is as though these lines of force acted like two compressed helical springs under unequal compression. The tendency of the mercury conductor to stretch or lengthen itself is therefore greater at one end than at the other, hence the short movement until a balance is reached.

If this is correct, an alternating current which would give a continuous rapid succession of such impulses should produce a continuous motion. When tried, it was found to do so, the piece moving very

decidedly and with an apparently constant velocity across the bath to the other pole; reversing its position, it moved in the reverse direction. A counter e.m.f. must have been generated during this motion. The surface of the mercury did not show the agitation which a pinch effect would have caused, and the cross-section of the mercury was rather large for causing any marked pinch effect. The experiments were merely preliminary and somewhat crude, though apparently quite decisive. It is admitted that the pinch effect, if quite great and in a long narrow trough, would add to this force by a secondary hydraulic action, and that it would then produce continuous motion with direct current also; but the writer has shown in numerous other experiments that the same longitudinal force produced apparently by this repulsion of like lines of force acts also on solid conductors, in which of course hydraulic action cannot exist. A short piece of a well-amalgamated chain of copper links laid loosely on the mercury in a trough longer than the chain stretches itself straight when current was passed through the trough; if this motion had been due to the pinch effect at the two end links, it ought to have contracted the chain.

THIS FORCE NEGLECTED BY PHYSICISTS

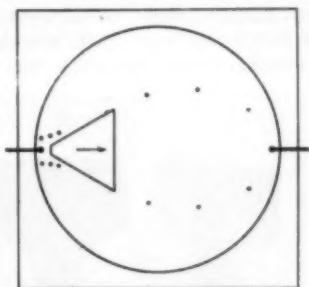
This longitudinal electromagnetic force has been neglected by physicists, presumably because it happens to be zero in what appears to have been the fundamental case on which our present mathematical treatment of such forces was based, and it was thereby lost sight of.

There are two, and apparently there are only two, well-known magnetic forces which can properly be called the primary ones, at least until it can be shown that one is the resultant of the other; these are the contraction of a line of force and the mutual repulsion of like lines. A general mathematical formula should have contained both, as cases might arise like the above, and others which the writer could cite, in which these longitudinal forces do not add up to zero, or act if given the freedom to do so. Development in this field has, in the past, been checked by the fact that this longitudinal force had unfortunately been outlawed by physicists; we know that this force does exist, though in the more usual cases (but apparently not in all) it drops out because two equal and opposite forces balance each other, or because the necessary freedom of motion does not exist.

A really complete mathematical treatment ought to contain three fundamental or primary factors, instead of only one, as these forces act in space of three dimensions and the resultant in space is in the most general case dependent on all three; in most cases one or two drop out, but there seem to be some in which they do not. Referring to the flux encircling a conductor, these three directions of forces are: The usual one which is radial to the conductor, the longitudinal one (repulsion of like lines) and the tangential one (force on a unit pole).

Such a complete treatment would then apply when any one or two are zero, for some of which cases the usual system fails.

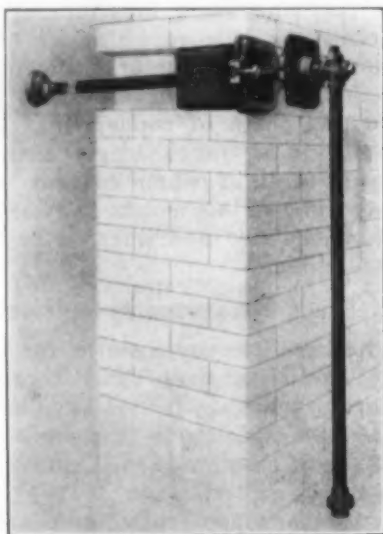
The writer could cite experiments in which each one of these three forces is the only one, in the particular experiment, to produce the motion, the two others being inactive. There are indications that the ether acts something like a liquid with respect to these forces.



Flue Gas Filter for CO₂ Equipment

The main essential for the satisfactory operation of recording carbon dioxide equipment is cleanliness of the flue gas sample. In order to eliminate the deposition of soot in the sampling lines and the recording apparatus, the Uehling Instrument Co. has developed a filter which may be placed on the inlet end of the gas sampling line inserted in the flue or last pass of the boiler. The filter consists of a heavy but highly porous disk of refractory material which is held in a cup-shaped casting by means of a bolt.

Formerly the gas was withdrawn through an open-ended pipe and the filtering was accomplished with cot-



UEHLING FILTER FOR FLUE GASES

ton waste, this necessitating more or less frequent blowing out of the gas line and renewal of the filtering material. With the new arrangement, the soot builds up on the "Pyroporous" filter and does not appear to enter the pores to any extent—in fact some of these filters have been in service for months without having been blown out or replaced and without offering appreciably increased resistance to the gas flow.

It is not yet known what life may be expected of these filters, but present indications are that they will last for several years without attention. They are, however, inexpensive and are easily replaced. To facilitate inspection and replacement the manufacturer has also developed a frame to be inserted in the brickwork and a holder for the sampling pipe. In the illustration the holder is shown detached from the frame. It is quickly fastened in place by two bolts. By loosening the nuts on these bolts and by unscrewing the union shown at the bottom of the section of sampling line the filter may be withdrawn through the frame. The frame is the width of two bricks, hence it is a simple matter to insert it in the setting without cutting a large hole in the brickwork. When the sampling line is to be inserted through a metal casing, as with a horizontal tubular boiler, the frame is omitted and the holder is bolted directly to the metal casing of the boiler.

The filter may be used for any type of recording or testing instrument where clean gas is desired, and the frames and holders may be adapted for the installation of pyrometers, draft gages and for providing convenient openings in the furnace for test and observation purposes.

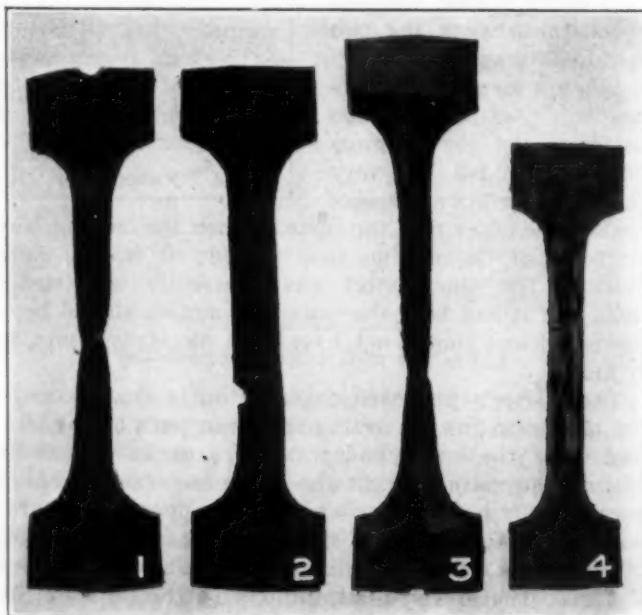
Synopsis of Recent Chemical & Metallurgical Literature

Properties of Single Crystals of Aluminum.—H. C. H. Carpenter and Miss C. F. Elam have described¹ experiments on "Crystal Growth and Recrystallization in Metals," where they demonstrated that crystals in a commercial aluminum sheet would not grow or be absorbed upon annealing if not previously overstrained. A certain amount of overstrain caused a few crystals to grow by boundary migration; a larger deformation caused recrystallization starting from a multitude of centers at former grain boundaries.

Working recently² with very pure cold-rolled aluminum sheet (Al 99.6 per cent, Si 0.19 per cent, Fe 0.14 per cent), test-pieces measuring 4 in. x 1 in. x $\frac{1}{2}$ in. were converted into a single crystal thus: Recrystallizing by annealing 6 hours at 550 deg. C.; stretching 1.6 per cent on 3 in. by loading at 2.4 tons per sq.in.; then heating in a furnace whose initial temperature was 450 deg. C., and raising it 20 deg. per day up to 550 deg. C., and subsequently heating 1 hour at 600 deg. C. to effect the absorption of persistent small surface crystals.

Prof. William Bragg examined some of those large crystals by his X-ray method, and confirmed not only Hull's conclusion that they are built up on a face-centered cubic lattice, but the metallographist's assumption that etching is a reliable method of distinguishing crystals in a metal. However, these crystals may be placed at any angle to the line of load, consequently the tensile properties will vary widely. Still each specimen exhibited the wedge-shaped fracture predicted by Jeffries and Archer.³ The authors recognize five types of fractures, as shown in Table I.

A word descriptive of type 5 may be included. These produced twins in various numbers. Slip-bands change direction at these twin boundaries, and recrystallization commences here, but they are invisible in a repolished and



FIGS. 1 TO 4—TEST-BARS OF ONE CRYSTAL. FRACTURES OF VARIOUS TYPES

etched section except under oblique illumination. Some twins looked like large fibers (Fig. 4). Others showed merely a narrow straight dark line on the test-piece; they often occurred at the edges. Fig. 5 shows the plan and

¹J. Inst. Metals, vol. 24, p. 83 (1920), No. 2. Summarized in CHEM. & MET. ENG., vol. 24, p. 224 (Feb. 2, 1921).

²Proc. Roy. Soc., Series A, vol. 100, No. A704; p. 329 (Dec. 1, 1921.)

³CHEM. & MET. ENG., vol. 24, p. 1058 (June 13, 1921).

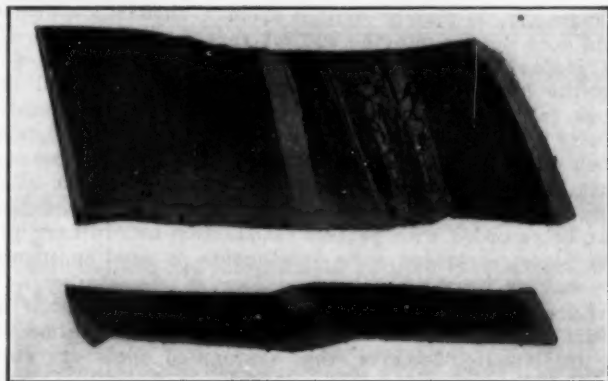


FIG. 5—SIDE VIEW AND CROSS-SECTION OF A TEST-BAR WHICH TWINNED LENGTHWISE

cross-section of one crystal which turned at the edges in opposite directions and at the center, all on parallel planes.

Many test-pieces were pulled which consisted of two abutting crystals. In no case did fracture occur at the junction; in fact, mutual support was clearly in evidence to a depth of $\frac{1}{4}$ in., leaving the boundary as a pronounced ridge. If crystals existed side by side, one frequently broke before the other, and on reassembly a gap of $\frac{1}{4}$ in. was often noticed.

Round bars, 0.56 and 0.8 in. diameter, consisting of a single crystal, always flattened in one dimension as much as 45 per cent, leaving the other substantially unchanged. Fracture always occurred in a curious way; both pieces were cupped, forming a groove on reassembly.

Single crystals are remarkably malleable, remaining quite ductile after cold reduction of 93 per cent with no annealing, a property far in excess to the normal sheet. Brinell depressions made in single crystals were almost square, with rounded corners.

Carpenter and Elam conclude their paper with a brief

TABLE I—CHARACTERISTICS OF SINGLE CRYSTALS OF ALUMINUM

Type	No. of Specimens	Characteristics	Fracture	Figure	Strength, Long Tons Per Sq. in.	Elongation, Per Cent
1	7	Slips reduce breadth only	Severe necking	1*	2.9 to 3.9	57 to 67
2	7	Slips reduce thickness only	Straight knife edge	2	2.8 to 3.3	47 to 73
3	15	Slips reduce both dimensions. Cross-section becomes rhomboidal	No neck	3	2.9 to 4.08	34 to 86
4	8	Like type 3, but necks	Local neck	3	3.1 to 3.8	53 to 79
5	5	Develops mechanical twins	Various	4	3.0 to 3.8	55 to 67
Normal	5	Sheet as received, but reheated 6 hr. at 550 deg. C. About 150 crystals to the linear inch	Slight neck	..	4.5 to 4.7	36 to 38

*Some of the specimens were lightly ruled in squares before testing.

discussion of the cause of grain growth. They have been of the opinion that mechanical deformation supplied the energy required, and heat supplied only the necessary mobility. Amorphous metal produced during deformation cannot be a store of recrystallizing energy, since maximum deformation does not correspond to maximum crystallizing power. Such questions will await the investigation of the actual changes in the space lattices of large crystals when subjected to plastic deformation, a research which is under way in collaboration with Sir William Bragg.

Importance of Time in Heat-Treatment of Chromium Steel.—Notwithstanding the general understanding that temperature control is essential to correct heat-treatment, direct attention is seldom given to the no less important factor of time, Prof. C. A. Edwards pointed out at a recent

*It is somewhat surprising that the normal specimens have such moderate strength in comparison with that of crystals 2,000,000 times as big, in view of the undoubted aid given by adjacent crystals.

meeting of the British Institute of Metals in Birmingham. For instance, ordinary carbon steel, suitable for files, if quenched in water will be glass hard, but if a slightly longer time be allowed for cooling between 800 and 400 deg. C. it will be very soft. Hence the impossibility of deep hardening massive pieces of such steel—it is impossible to quench the underlying metal at a sufficient rate—and the use of alloying elements such as Ni, Cr, W or Mn, which act on hardness in the same direction as rapid cooling. However, many special steels are no less sensitive to the time at heat than high-carbon steel. For instance, a steel containing 0.33 per cent C, 3.1 per cent Ni, and 1.6 Cr, will exhibit markedly different cooling curves and different strength and hardness as it is cooled even at the same rate from varying temperatures between 814 and 874 deg. C. Again, chromium steels are sensitive or not depending upon whether the ratio between chromium and carbon exceeds 10 to 1. If there is more than enough chromium to satisfy the carbon as Cr_3C_2 , then the steels no longer act as plain carbon steels, and the initial temperature of quenching ceases to have influence on their critical cooling velocities. A sample of 0.4 C. steel having 12 per cent chromium requires a cooling rate of more than 60 minutes to permit the transformation to progress. High-carbon, high-chromium steels (like 1.2 per cent C, 10 per cent Cr) will exhibit increasing hardness as the quenching temperature rises to 1,000 deg. C., but decreasing hardness when quenched higher. Thus its Brinnell hardness is about the same when annealed and when quenched from 1,200 deg. C. This is somewhat misleading, however, for, like high-manganese steels, they cannot be machined. Also "tempering" at 600 deg. C. or higher greatly increases the hardness.

Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Artificial Silk.—Brilliant threads of viscose silk are obtained if the freshly precipitated gelatinous threads spun in a sulphuric or other acid bath are wound up on spools, etc., in a solution of ammonium chloride or sulphate. The ammonium salt bath is maintained neutral or of the desired degree of acidity by the addition of aqueous ammonia or acid. The viscose may be in the fresh or ripened condition, and it is preferred to employ concentrated solutions. (Br. Pat. 171,776. Technochemia Akt. Ges., Glarus, Switzerland. Jan. 11, 1922.)

Sodium Cyanide.—Sodium cyanide is produced by the action of nitrogen on a mixture of sodium carbonate and carbon, the latter being preferably in large excess. To prevent the destruction of the cyanide through contact with the other reaction products, the furnace is provided with a pervious hearth through which the reaction products are withdrawn, while the furnace space is filled, for the most part, with reducing gases which are burned in the upper part of the furnace. The furnace hearth may consist of hollow iron plates stood on edge, through which water or cold gases are passed to cool the reaction products. If necessary, the water or other cooling medium may be injected into the reaction products to produce ammonia and soda, the latter being returned to the furnace. (Br. Pat. 172,027; not yet accepted. H. Mehner, Berlin. Jan. 18, 1922.)

Decolorizing Liquids.—Sugar solutions and other liquids are decolorized by the use of an adsorbent and a reducing agent in conjunction. The reducing agent may be applied first, or some adsorbent may be applied first and filtered off and the reducing agent may be applied, followed by more adsorbent, or the adsorbent may be allowed to remain in

*Reported in the Iron and Coal Trades Review, Jan. 27, 1922, p. 121.

contact with the material while the reducing agent is applied. Examples are given of the treatment of sugar solution with bone charcoal and sodium hydrosulphite. Sulphur dioxide may also be employed. (Br. Pat. 172,272; not yet accepted. J. F. Straatman, Holland. Jan. 25, 1922.)

Soaps and Fatty Acids.—A process for deodorizing liquid soaps containing water or converting fatty acids with several double bonds into homologs of oleic acid consists in forcing the substance under pressure through a pipe heated to about 250 deg. C. The heating may take place in two stages, in which case the second portion of the pipe may be heated up to 300 deg. C., and further quantities of alkali may be added by means of a separate pipe before the second stage is reached. A suitable pressure is 70 atmospheres. (Br. Pat. 172,250. Henkel et Cie., Dusseldorf. Jan. 25, 1922.)

Book Reviews

THE CHEMICAL AND METALLOGRAPHIC EXAMINATION OF IRON, STEEL AND BRASS. By Wm. T. Hall and Robert S. Williams. New York: McGraw-Hill Book Co., Inc. 502 pp., 183 illustrations. Price \$5.

About two-thirds of this volume is taken up with methods of chemical analysis, and the remaining third with metallography. The former portion is the more valuable. Various methods for the analysis of all possible constituents of iron and steel are not only given in detail as to procedure, but are also explained in principle or theory, and the different methods for the determination of a given element are compared and criticized in an interesting way. Quoting from the introduction, the book "is written more from the point of view of the educator than from that of the busy analyst," and not "for the chemical laborer so much as for the man who wants to know and to understand methods of chemical analysis." Judged from this point of view, the book is certainly a success as applied to iron and steel, and few adverse criticisms of that portion can be made. A serious omission is that of any method for the determination of alumina or of total non-metallic inclusions in steel. The table of oxygen contents of various steels on page 257 would be much more interesting to a metallurgist if more data had been given on the history of the samples during manufacture. But it is plain throughout the book that it is written by, and intended for, chemists, rather than metallurgists.

The chapter on electrometric methods is excellent, with its brief explanation of electrical terms and electrolytic theory. One of the best points about the book is the stress laid throughout upon the importance of proper sampling in order that an analysis may be of value. This certainly cannot be emphasized too much, to those who use as well as those who make chemical analyses, and the troubles arising from segregation and other non-uniformity of materials are well brought out by the authors.

The non-ferrous chapter is brief and rather peculiarly arranged, and evidently was considered of secondary importance. Methods for the determination of copper, tin, zinc, lead, phosphorus, nickel, arsenic, antimony, etc., are given, but there is no mention of the rapid method for deposition of copper by means of a solenoid for rotating the solution as advised by Frary, instead of by use of a rotating anode. Neither is any method given for the determination of sulphur in bronze. A glaring error is the wrong definition of manganese bronze on page 307. Theoretically perhaps this term *should* denote a "copper-tin alloy to which manganese has been added," but practically what is now called manganese bronze is an impure copper-zinc alloy, and it would seem that a book of this kind should recognize facts as they are, even though it might be necessary to explain that the name as commonly used is illogical and should eventually be discontinued. In this as in several other places in the book it appears that the authors are just a trifle out of touch with the practical applications of metallurgy, so that their ventures into this realm are not always wholly successful.

Part II, or the final third of the book, dealing with met-

allography, is plainly written from a chemist's viewpoint, and does not go into the subject very deeply. The method of preparing specimens is outlined, with some useful notes on the microscope and photography, but the usual textbook fallacy in regard to the necessity for color-sensitive plates in non-ferrous work is repeated. In certain instances such plates may be an advantage, but those instances occur just as often with iron and steel as with copper alloys, and the vast majority of work with all kinds of metal can be recorded with perfect satisfaction on ordinary process plates, provided some intelligence is used in printing as well as negative-making.

Excellent discussions are given of the iron-carbon diagram, metallographic constituents, and segregation. It is unfortunate, however, that segregated spots are stated to include oxides, for this is extremely doubtful and certainly not demonstrable by the microscope, which shows them only in decarbonized areas. Macroscopic methods of investigation are described, including the making of sulphur prints, but the latter process, while correct in principle, is not given in a specially practical manner, and would appear to have been described by some one who had not made very many of these prints successfully.

A chapter on the general study of steel with the microscope indicates some of the ways in which this work might be useful to the chemist, or as supplementing the chemist's report, and two very good chapters follow on the structural features of cast iron. Sampling is discussed in detail in another chapter, and magnetic and X-ray testing are briefly described. It is hard to see why they should be given under "Sampling," however.

The final chapter, on non-ferrous metallography, is good on the whole, though rather brief on all phases of this subject except the brasses. A few rather serious errors and omissions occur, however, in this chapter, and a revision of certain parts would be decidedly beneficial. The discussion of beta brass and Muntz metal on page 455 does not agree very well with that on page 467, and the careful reader who might be attempting his first study of the subject from these pages could scarcely fail to be confused by them. The trouble is that it is not explained on page 455 that true equilibrium as represented by the copper-zinc diagram is probably never attained in this alloy under practical conditions, so that both pure beta and alpha plus beta structures are often found in the commercial alloy, whether quenched or cooled slowly. The conditions here are quite different from those met with in bronze, as described on page 456, where it is difficult to retain beta below the transformation temperature. The important delta constituent of bronze is not discussed at all, though its occurrence and distribution are among the most important points to be determined in metallographic work on this alloy. The statement that copper alloys may contain copper oxide is erroneous, as this oxide is found only in the pure metal, and all ordinary alloying elements promptly reduce it, becoming oxidized themselves instead. The bad effect of oxide on conductivity is also a fallacy, as it has less effect in this way than almost any other impurity in copper except lead.

Thus in general it may be said that the chemical part of this book is an excellent and interesting guide to the thoughtful analyst, while the metallographic part is not quite so good. Of course it could not be expected that in a book two-thirds devoted to chemistry the subject of metallography would be thoroughly covered, but on the other hand it is disappointing to note so many errors that might have been avoided by a little more care.

Steel-works chemists using this book could scarcely fail to find it a help in their analytical work, and if they wished to take up metallographic investigations, as the authors very sensibly advise, they would undoubtedly get a fair start from it along this line. But it would not be long before they would find problems in manipulation to be solved by personal experience, and other problems on which the help of a more advanced text would be required. To the worker in non-ferrous metals exclusively the book is not to be recommended, as there are other books available that cover this branch of the subject more completely.

GEORGE F. COMSTOCK.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Muscle Shoals Developments Lag in House and Crowded Out by Treaty Interest in Senate

Some time is expected to elapse before any important step is taken by Congress in the pending negotiations involving the Muscle Shoals project. The Senate, in the throes of the treaty fight and about to take up tariff legislation, is having difficulty finding the time to give consideration to so intricate a matter as the disposal of the plants and waterpower at Muscle Shoals. The Senate Committee on Agriculture will probably not be able to visit the plant until the latter part of March. Fifty Senators have indicated their desire to investigate the plant.

Several efforts have been made in the House to bring its hearings to a close. The ramifications of the proposal, however, have made it impossible to carry those plans through, with the result that the record is assuming formidable length. No proposition before the Military Affairs Committee of the House has enough strength to make it advisable to press the proposition for an early vote in committee. The friends of the Ford offer believe that delay will work in their favor in that the desires of the public will be manifested anew when the results of the hearing are summed up. They believe this will bring into their ranks two or three members of the committee who still are non-committal. On the other hand, the opponents of the Ford offer think they will gain by any delay. As a result there is no great pressure for a prompt report on the matter. Chairman Kahn of the House Military Committee has introduced a resolution in the House authorizing that committee to visit the plant for investigation.

Senator Culberson of Texas has announced that he favors the sale or lease of the plant to Henry Ford.

During a Senate debate on the subject, Senator Norris of Nebraska, chairman of the Agricultural Committee, which is considering the various lease offers, said he was drafting a bill which he will introduce in the Senate providing for government operation of the plant. While he has not made up his mind as to the value of the various offers for lease, he said the Senate should seriously consider the possibility of government operation in view of the large expenditure heretofore made on the plant by the government. He favors independence from foreign fertilizer materials and, from the fertilizer trust alleged to exist in the United States.

Senator Heflin of Alabama favors acceptance of the Ford lease offer. Senator McNary of Oregon said serious consideration should be given to all lease offers, and expressed a desire to know if the Alabama plant could compete with the Niagara Falls nitrate plant. Senator Smith said there should be no quibbling over the various offers, but the matter should be decided in the light of benefit to agriculture. Senator McNary said Ford's offer should not be accepted until every offer had been studied. Senator McKellar of Tennessee favored the Ford offer and referred to the phosphate available in the South.

Appropriation Announced for Bureau of Chemistry

The House Committee on Appropriations, in reporting the bill carrying funds for the Department of Agriculture for next year, provides \$1,267,631 for the Bureau of Chemistry, which is \$32,620 less than appropriations for the current year and \$7,080 less than the estimates.

Swedish Fertilizer Workers Strike

Socialdemokraten reports that the workers at the Stockholm phosphate mills have struck. This means that workers at all the fertilizer works in Sweden, totaling 1,200 hands, are striking.

McGraw-Hill Company Purchases "Mining and Scientific Press"

The McGraw-Hill Co., Inc., publisher of *CHEMICAL & METALLURGICAL ENGINEERING*, has purchased the *Mining and Scientific Press* of San Francisco and on April 1 will consolidate it with the *Engineering and Mining Journal* under the name of *Engineering and Mining Journal-Press*. These two publications are the leading magazines of the metal mining industry, the *Journal* having been established in 1866 and the *Press* in 1860. J. E. Spurr, editor of the *Journal*, will be editor of the combined weekly, while T. A. Rickard, editor of the *Press*, will be contributing editor, keeping his residence in San Francisco and representing, in particular, the coast and Western viewpoints. The combined publication will be issued in New York.

Secretary of Interior Urges Government Aid in Development of Western Potash Fields

Development of potash deposits on public lands in the West under more liberal leasing laws or under a government revolving fund is recommended by Secretary of Interior Fall. He believes that potash deposits exist in sufficient quantities in the Western country to "relieve us of the monopoly existing at present under the control of Germany, which furnishes to our people practically all the potash which we use in America." He recommends that Congress either liberalize the law so that private capital may be attracted to the development of the fields or provide a revolving fund to be used by some government department in prospecting for mineral deposits. The result of such prospecting would enable operation under the second provision of the leasing law and permit the government to sell or lease lands in the potash and phosphate fields upon bonus and royalty and surface rental basis.

The House Committee on Appropriations, in reporting the bill carrying funds for the Department of Agriculture for next year, recommends \$70,000 for the Bureau of Soils for exploration and investigation of methods of obtaining potash, nitrates, etc.

To Investigate Foreign Chemical Markets

Director Klein of the Bureau of Foreign and Domestic Commerce recently requested of the House Appropriations Committee funds for investigations of chemicals. He said the chemical industry was considerably stimulated in this country during the war, especially in the manufacture of heavy industrial chemicals, and the bureau desired to study the possible markets in new industries in Latin America for chemicals.

In the manufacture of soap, for example, there is a considerable market to be found for caustic soda and other commodities where a market did not exist before the war. The bureau is anxious to find markets and see that American chemicals are placed there. He said there would be a demand for these chemicals for new industrial activity in Latin America.

British Imports of German Dyestuffs

In reply to a question in the House of Commons, Hildon Young stated that the total weight of dyestuffs received by Great Britain from Germany by way of reparation up to Dec. 31 last was 4,070 tons, of which approximately £570,000, or £140 per ton, was credited to Germany. Two thousand four hundred tons had been sold for approximately £228 a ton, which represented the values ruling at the date of the sale.

Chemical Industry in the Tropics Subject at New York Section, A.C.S., Meeting

The spicy tang of the Oriental tropics pervaded Rumford Hall at the meeting of the New York Section of the American Chemical Society on March 10, when two interesting papers, illustrated with attractive stereopticon slides, were presented on the place of the chemical industry in the tropics. R. F. Bacon of New York spoke on "The Tropics as a Source of Chemical Raw Materials." Dr. Bacon spent 5 years in the Eastern tropics and is familiar with the present applications and the undeveloped possibilities of tropical products. He pointed out that the field of the industrial chemist is in working up processes for making the tropical natural products more transportable and more available for consumption in the temperate countries. He described the industry built up around the coconut palm, including the drying of the copra, the collection of the sap and the extraction of the oil. The wonderfully rapid growth of vegetation suggests the development of tropical woods and grasses for paper manufacture. The prolific yield of tropical soil suggests the cultivation of casaba as a logical source of starch. The speaker predicted a steady increase in the amount of oils that will be imported from the tropics, due to the flexibility afforded consumers by newly developed hydrogenation processes. He also voiced the opinion that some of the effort now directed toward the perfection of synthetic methods might be more profitably turned to the development of the tropical sources of the natural products. The slides included photographs of the cultivation and harvesting of essential oil-bearing plants, rubber, cloves, etc., and the extraction of perfumes and oils from the plants in native distilleries.

"A Unique Alcohol Industry and a New Source of Sucrose" was the subject of the paper presented by H. D. Gibbs of E. I. du Pont de Nemours & Co. Dr. Gibbs discussed the occurrence and extraction of sugar in different varieties of palm trees and described the sugar industry that has been developed in the Philippines using this source of supply. The nipa, coconut, sugar and fish-tail palms are the best sources of sugar among the palms, but the nipa is the only one commercially important in the Philippines. It grows in swampy land along the rivers. The sap is obtained by cutting the flower stalk and hanging a small bamboo joint under it. It is necessary to cut a slice from the end twice each day to maintain a steady flow of sap. The average yield is about 43 liters per season per plant, the plants maintaining this production without decrease for as long as 50 years. The yield can be doubled by scientific cultivation and harvesting methods. The nipa palm is the source of 90 per cent of the alcohol produced in the Philippines, and at its price of 2 cents a liter is probably the cheapest raw material known. It is not suitable for sugar manufacture, however, since it is contaminated with yeasts. The sap contains about 15 per cent sucrose. Among the slides shown were photographs of the native distilleries and nipa palm plantations. Several very interesting photographs of different varieties of palm trees taken with infra-red light rays were shown.

New Bulletin on Carbon Monoxide Poisoning

Carbon monoxide poisoning is discussed by Dr. Alice Hamilton of the Bureau of Labor Statistics in Bulletin 291 of that bureau. This publication gives a full technical discussion of the symptoms and causes of both acute and chronic poisoning and points out many industrial sources of carbon monoxide gas where danger to operatives is met. Not only safety engineers of corporations, but also those generally responsible for plant conditions will find much of value in this publication. It can be obtained direct from the Bureau of Labor Statistics, Washington, D. C.

Industrial Chemical Exhibit at Union College

An exhibition covering products and processes of practically all industrial applications of chemistry will be given in the Butterfield chemistry building by the Union College Chemical Society of Schenectady. The exhibition will be opened April 6 and will continue for a three-day period.

Third Week of Dye Investigation Brings No Substantiation of Monopoly Charges

No one of the accusations which have been made against the domestic organic chemical industries has been substantiated. At the time of this writing, the hearing before the Senate sub-committee is in its third week. The charges that have been made are numerous. In nearly every case they go back to some previous public record, but the proof which the original accusation lacked is still wanting. No consumer of dyes has come forward to testify that there is a monopoly or that efforts are afoot to consummate a monopoly. No small producer of dye materials has been brought forward to testify as to efforts to gobble him up.

There is abundant evidence that the instigators of the investigation are likely to suffer more as a result of its disclosures than are those whom they accuse. It is quite apparent that the representatives of the organic chemical industries have made a very favorable impression on Senator Shortridge, the chairman of the sub-committee conducting the probe.

Francis P. Garvan, president of the Chemical Foundation, was able in the course of his extended testimony to explain away many of the fanciful accumulations of accusations which had been brought against the industry. He feels, in the light of the information which he has given the committee, that the tissue of charges brought by Senator King have been discounted. Senator Moses of New Hampshire, who long has been active in laying much wrong-doing at the door of the domestic dye-manufacturing industry, has contributed nothing to disclose these iniquities. He has attended none of the hearings and as this is written is away from Washington.

CHEMICAL INDUSTRIES PROFIT BY OPPORTUNITY TO PRESENT VIEWPOINT

The representatives of the chemical industries in attendance at the hearings are more than satisfied with the way things are working out. They point out that this is the first time the chemical manufacturers have had an opportunity to present their side of the case. Such defense as they have been able to make before Congress has been as an incident to the tariff hearings. The very nature of those hearings was such as to preclude any thorough defense such as now is possible before the Shortridge committee.

From a textile source comes the opinion that the whole investigation really has had its inspiration in the dye industry and that the hearing was timed carefully so as to enable the dye people to obtain wide discussion of their arguments for an embargo at the time the Finance Committee is whipping the tariff bill into final shape. If such were the case, it would necessarily imply collusion with Senator Thomas, Senator King and Senator Moses, who have been consistently working for more than 2 years to secure the investigation. In chemical circles it is pointed out that at least some of the accusers of the dye interests suddenly lost their enthusiasm when the Senate adopted Senator Frelinghuysen's amendment broadening the scope of the investigation so as to include an investigation of the practices of dye importers.

When the investigation reaches the point where the activities of the importers are to be considered, a sensational disclosure is said to be in prospect.

GARVAN CONCLUDES TESTIMONY IN DEFENCE OF CHEMICAL FOUNDATION

Mr. Garvan concludes his extensive testimony in defense of the dye manufacturers and the Chemical Foundation, declaring that he had given a complete answer to all the charges made by Senator King. He expressed willingness to answer any questions that may be asked by Senators King and Moses, who will be invited to cross-examine him. In the course of his testimony, Mr. Garvan expressed the belief that the decision of the sub-committee to place all witnesses under oath drove to cover those who have been conducting a whispering campaign to prevent the development of the American dye industry. Witnesses hostile to

development of the American industry, if required under oath to give the source of information contained in their statements, would show by their answers that their information originated with supporters of the German chemical cartel, he declared.

The Chemical Foundation, far from being the powerful, wealthy organization alleged by its enemies, has expended all of its income and part of its capital in the public interest to educate American public opinion to the necessity of developing the science of chemistry, stated the witness.

SAYS TARIFF CANNOT PROTECT DYE INDUSTRY AS EMBARGO CAN

Senator Sterling brought up the question of tariff by inquiring why a high tariff could not protect the American dye industry as well as an embargo.

"No tariff can be high enough because no price is too high for Germany to pay to destroy the American industry," responded Mr. Garvan, and continuing, he declared that Germany is willing to pay any price, even to the extent of giving away its dyes plus a bonus for using them, in order to destroy the American industry. The embargo, he explained, makes it possible to keep out foreign dyes which are manufactured here satisfactorily, whereas Germany would crash through any tariff wall regardless of expense. "She wants to regain commercial domination. She wants to regain military control of the world," he concluded dramatically.

In answer to Senator Sterling's inquiry as to how reasonable American prices are, the witness replied that competition among American producers during the time they have been protected by government control of imports has brought prices down to the proper limits to the consumer.

JEFFCOTT DEFENDS INSTITUTE AND RIDICULES MONOPOLY CHARGES

Declaring that "intensive, bitter, cut-throat competition" exists today in the American dye industry instead of the monopoly charged by Senators Moses and King, R. C. Jeffcott, president of the American Dyes Institute, challenged and denied most of the charges made by King. Mr. Jeffcott is president of the Calco Chemical Co. and is the first dye manufacturer to be heard by the committee.

In defending the American Dyes Institute against the charges that it is the center of a dye monopoly in the United States and that it has expended money for insidious propaganda and improper lobbying in connection with legislation for the complete protection of the dye industry, Mr. Jeffcott went into some detail as to the individual members of the Institute and the various expenditures. The charge that the large dye manufacturers meet to arrange and agree as to prices, through the Institute, was emphatically denied by Mr. Jeffcott.

Contrasting the alleged monopoly with the condition which he claims actually exists, Mr. Jeffcott declared the manufacturers appear to be so suspicious of one another that they not only refuse to give statistics concerning their business but will not work together to the extent called for by the present situation. He also stated that prices of American dyes are down to pre-war levels and some products are being sold under cost of production because of competition.

Under cross-examination by Senator Shortridge, Mr. Jeffcott was asked what is necessary to protect the American industry.

"First of all," he replied, "we should have a selective embargo for 5 years, then for the ensuing 5 years protection under the highest possible tariff rates, after that the same degree of protection as is accorded to other American industry against foreign competition would be ample. The only way to make protection effective is to make it certain. We have had no feeling of security, no assurance as to how long we will have an embargo. We feel that misunderstanding on the part of Congress is solely responsible for failure to give the industry proper protection."

Mr. Jeffcott said that time is an important element in developing the American industry, as before the war there

was practically no such industry. The development of the American dye industry will bring American science to the aid of industry, he predicted, with benefits of incalculable value resulting.

TEXTILE INTERESTS NOT OPPOSED TO TARIFF

Textile interests opposed to adequate protection of the American dye industry constitute only a minority of the American textile industry, according to the testimony of Morris R. Poucher of E. I. du Pont de Nemours & Co. and chairman of the legislative committee of the American Dyes Institute. Mr. Poucher presented a summary of the activities of the legislative committee of the American Dyes Institute and also made a statement concerning the activities of importers of German dyes to prevent development of the American industry and denying certain of the testimony of Senator King of Utah before the sub-committee.

"In the final analysis there is but one question," he said, "and that is, do we want this industry in the United States, or do we not? America will answer 'Yes' and the German dye monopoly will answer 'No' and that is the sum total of the whole controversy."

OPEN PRICE SECTION NOT SUCCESSFUL

Harry E. Danner, treasurer of the American Dyes Institute, described in detail the work and purposes of the open price section, which was formally abandoned in June, 1920. Mr. Danner said that when this section was organized, in 1918, only five of the sixteen companies then members of the Institute participated in the section, and that no more than twelve Institute members at the most ever participated in it.

In reply to questions from Senator Sterling, Mr. Danner said the American Dyes Institute was originally organized to have an open price section, but that the latter failed, probably because the dye industry was new and its members did not like the idea of giving information about their business. No penalty was enforced, he said, against members not participating, as membership was voluntary. The difference between those participating and those not, he said, was that those who made reports received the information exchanged, while non-participating members did not.

TEXTILE MANUFACTURER NOT SATISFIED WITH INVESTIGATION

A letter severely criticizing the conduct of the sub-committee of the Senate Judiciary Committee in charge of the dye hearing was left with the sub-committee by George Deming, a Philadelphia lawyer. The letter complained, in effect, that the sub-committee has permitted representatives of the American dye industry to appear voluntarily, give their testimony and depart without adequate testimony. Senator Shortridge, through one of the stenographers at the hearing, made an unsuccessful attempt to locate Mr. Deming as soon as he ascertained the contents of the letter, which bore the typewritten signature of "John Nash McCullough, industrial manager, National Association of Hosiery and Underwear Manufacturers."

Senator Shortridge then publicly replied to the allegations in the letter and later announced that Mr. Deming will be invited to appear before the sub-committee, in order that he and any clients he represents may have full opportunity to present any evidence they believe of value to the inquiry now going on.

Forty Tons of Sulphur Per Day Limit Set on Smelter Stacks

In the suit of the State of Georgia against the Ducktown Sulphur, Copper & Iron Co., which seeks to restrain damages to crops by reason of discharge of sulphur gases, a stipulation has been filed in the Supreme Court by both parties under which the company agrees not to permit the escape into the air of sulphur dioxide gases which have a sulphur content of more than 40 tons a day, and to furnish the state a report as to the tonnage of ore smelted and acid made. The agreement also calls for a board of arbitration of one representative each of the state and the company to supervise operations and to ascertain damages caused to citizens by the gases.

Distributing Agencies at Fault in Fleischmann Alcohol Case

All permits for the sale of alcohol at branch plants of the Fleischmann Co., Inc., were withdrawn following an exhaustive hearing of the most important alcohol case that has come before the Bureau of Internal Revenue. The Commissioner of Internal Revenue declined to cancel the permits of the Fleischmann Co. to distill alcohol at its yeast plants at Langdon, D. C., and Peekskill, N. Y. The formal decision of the Commissioner states that the agents of the Fleischmann Co., Inc., at Philadelphia, Pa., Brooklyn, N. Y., and Bridgeport, Conn., diverted to unlawful purposes the alcohol produced by the company, and forwarded to them for distribution. There is no evidence to show that the unlawful diversion of alcohol by the agents of the Fleischmann Co., Inc., was known to the company or its officers or that such officers connived or conspired with their agents in such unlawful diversion, but it is established that the officers were negligent in the inspection of the agencies and did not use due care in supervising them.

The records kept at the distilleries of the Fleischmann Co., Inc., were found to be proper and correct and in accordance with the law.

As a result of the Fleischmann case a Treasury decision has been issued amending Sec. 58 of Article IX of Regulations 60, so as to set forth clearly the responsibility of manufacturers of alcohol who distribute their product through agencies. The new regulations place upon the manufacturer the responsibility for the conduct of a distributing agency in conformity with the law. Title to liquor in the hands of an agent remains with the manufacturer until title is transferred to a purchaser having a permit to purchase. The manufacturer must accept the risks of the business done through an agent. The agent must forward daily to the manufacturer for examination a complete report showing the details of all transactions of the agent. Each transaction must invariably be reported not later than the business day following the sale.

Industrial Developments of the Week

Paper.—The S. Y. Beach Paper Co., Seymour, Conn., is arranging for the early resumption of operations at its local mills, which have been closed down for about a year. The machinery will be overhauled and improved at once.

Ceramic.—The National Fireproofing Co., Pittsburgh, Pa., is maintaining active production at its different plants. During the month of February the company booked about twice the volume of business as in the same month of last year.

The New Castle Brick Co., New Castle, Pa., will soon resume production at its plant. Repairs and improvements will be made to the equipment at once.

Oil.—Nine oil refineries in the El Dorado district, near Monroe, La., will resume full-time production during the next fortnight, increasing production to a basis of 25,000 bbl. per day, with employment of 3,500 men.

Rubber.—The Goodyear Tire & Rubber Co., Akron, Ohio, has increased operations at its plant at Los Angeles, Cal., to a production basis of 25,000 tires a day.

Paint.—The Prince Metallic Paint Manufacturing Co. has placed its plants at Bowmanstown and Lehigh Gap, Pa., on a full-capacity basis.

Iron and Steel.—The Carnegie Steel Co. is increasing operations at its Mingo Junction plant in the Steubenville, Ohio, district, which has been running on a 75 per cent basis.

The Tennessee Coal, Iron & Railroad Co., Birmingham, Ala., a subsidiary of the United States Steel Corp., has blown in its Alice blast furnace at the local works. Production in all departments has reached practically a 100 per cent basis, making the first complete steel plant to reach this point during the past 24 months.

The Carbon Iron & Steel Co., Parryville, Pa., is completing repairs and overhauling of equipment at its mill, preparatory to early resumption of operations.

The Cambria Steel Co. has resumed production at its

open-hearth furnaces at the Johnstown, Pa., works. The company has sixteen furnaces in operation at its Franklin plant and is planning to resume manufacture at its Bessemer mills before March 25.

The Inland Steel Co., Chicago, Ill., has increased production at its East Chicago, Ind., works, adding about 1,000 men to the working force. The manufacture of steel rails has been resumed and a number of departments are operating on a 75 per cent basis, as compared with a 60 per cent schedule a few weeks ago.

The United Alloy Steel Co., Canton, Ohio, is now operating ten furnaces at its local plant and the majority of the mills are in service.

Coke.—The Century Coke Co., Brownsville, Pa., has resumed operations at part of its ovens. Other units will be placed in service at an early date.

The H. C. Frick Coke Co. has fired 700 additional ovens at its plant at Scottdale, Pa., and will place other ovens in service at an early date.

During the week of March 1, 270 additional merchant ovens in the Connellsville, Pa., section were fired.

Leather.—The Graton & Knight Co., Worcester, Mass., has increased operations at its local tanning and leather plant on a basis of 50 hours per week, giving employment to about 900 men. The factory has been working on a part-time schedule for some weeks past.

Eberle Tanning Co., Westfield, Pa., is operating under a capacity schedule at its plant for the tanning of buffalo sole leather.

The Craddock-Terry Co., Lynchburg, Va., has adopted a full-capacity schedule at its new central upper leather cutting plant, recently completed. A factory unit for the production of welts is being equipped and will be placed in service on a full manufacturing basis before the close of March.

Metals.—The New Jersey Zinc Co. is making ready to place its spiegel furnaces in operation at its Palmerton, Pa., works.

The Inspiration Copper Co., Globe, Ariz., has resumed the production of concentrates at its plant. Four sections of the plant are now in operation after a shut-down of about 9 months.

The Utah Copper Co., Salt Lake City, Utah, is arranging for the early resumption of operations at its plant.

The United Verde Extension Mining Co., Jerome, Ariz., has commenced operations at one of its reverberatory furnaces at its copper plant at Clemenceau.

The Silver King Coalition Co., Park City, Utah, is planning for the immediate operation of a new 450-ton mill now being completed. Timing-up will commence about the middle of March.

Changes in Specifications for Lubricating Oils

Certain changes in specifications for lubricating oils of various grades, which were advocated by refiners on the Pacific coast, were agreed upon at the first meeting of the recently formed Interdepartmental Petroleum Specifications Committee, held in the offices of the Bureau of Mines in Washington, D. C., Feb. 27. The changes have been submitted to the Federal Specifications Board, and it is hoped to incorporate them in the technical paper containing revised specifications for petroleum products, to be published shortly by the Bureau of Mines. The committee postponed the discussion of proposed changes in specifications for transformer oil, aviation gasoline, kerosenes and signal oil. It was decided to appoint a sub-committee on greases.

The personnel of the new committee is the same as that of the former Technical Committee of Standardization of Petroleum Specifications. The new committee, however, reports directly to the Federal Specifications Board. The revision of Bulletin 5 of the old committee, which was made last fall, has had the approval of the Federal Specifications Board, and will shortly be published in the form of two technical papers of the Bureau of Mines. Of these, Technical Paper 298 will relate to methods of testing petroleum products, and Technical Paper 305 to specifications.

British Alkali Company Reduces Wages

Notice of a reduction in the wages and holidays of chemical workers has been posted by the United Alkali Co., according to a dispatch from London. The 12½ per cent war bonus on time work and 7½ per cent on piece work are withdrawn in three stages—on March 2, April 6 and May 4. The bonus is being paid to operators, laborers and other workers. Directors of the company state that its withdrawal is justified in view of the continued depression in the volume of demand for the company's products, constantly falling prices and the decreased cost of living.

Cost of Analyses in State Laboratory

The State Department of Chemistry, Harrisburg, Pa., has compiled figures showing that the state agricultural chemists analyzed feeding stuffs, fertilizers, oils, paints and animal viscera during the past year at an average cost of \$4.76 per sample. A total of 2,876 samples of such materials were analyzed in 1921. The cost per sample includes all overhead charges, as rent, light, etc., at the Harrisburg laboratories, and in comparison with the work of the department at the prevailing cost, J. W. Kellogg, chief chemist, makes a comparison with the average charge of a commercial chemist at about \$20 a sample.

Personal

General AVERY D. ANDREWS has been elected president of the Shell-Union Oil Co., San Francisco, Cal., comprising the recent merger of the Royal Dutch Shell interests and the Union Oil Co. of Delaware.

L. J. BUCK has severed his connection with the National Carbon Co., a subsidiary of the Union Carbide & Carbon Corporation, and has become United States sales representative of the British America Nickel Corporation, Ltd., Ottawa, with office in the Canadian Pacific Building, New York City.

WILLIAM M. CORSE, general manager of the Monel Metal Products Corporation, will take active charge of the division of research extension of the National Research Council on April 1, succeeding Harrison E. Howe, now editor of the *Journal of Industrial and Engineering Chemistry*. In addition to his work for the National Research Council Mr. Corse will devote a part of his time to private consulting work.

JOSEPH B. ELAM has been appointed secretary of the Louisiana branch of the Texas-Louisiana division of the Mid-Continent Oil and Gas Association, with headquarters at Shreveport, La.

HARMON P. FISHER has been appointed engineer with the research division of the American Petroleum Institute. He was formerly in charge of operations at the United States Government helium plant No. 3 at Petrolia, Tex., and previously was connected with the Gellert Engineering Co., Research Corporation and the Westinghouse Electric & Manufacturing Co.

W. S. FRISBIE recently resigned his position as chief of the Bureau of Food, Drugs and Oil, State Department of Agriculture of Nebraska, to accept an appointment as chemist in charge of the office of co-operation, Bureau of Chemistry, Washington, D. C.

H. STUART HOTCHKISS, president of the General Rubber Co. and the United States Rubber Plantations, Inc., subsidiaries of the United States Rubber Co., New York, has been elected vice-president of the parent company in charge of overseas operations.

CLAYTON L. JENKS has opened an office at 2 Rector St., New York, for the practice of patent and trade-mark law. He will give special attention to chemical and mechanical inventions. Mr. Jenks was for 6 years assistant examiner in the U. S. Patent Office, organized and conducted a patent department for the Eastman Kodak Co. at Rochester, N. Y., and 5 years ago established a similar

system for the Norton Co., Worcester, Mass., of which he will retain charge.

H. A. MEGRAW has resigned as engineer for the Kennedy-VanSaun Manufacturing & Engineering Corporation of New York to become vice-president and treasurer of the Crown Oil & Wax Co. of Baltimore, Md.

GRAHAM L. MONTGOMERY, mechanical engineer, joined the editorial staff of *CHEM. & MET.* on March 1. He will devote his attention primarily to mechanical phases of the chemical and allied industries and to methods of handling materials.

J. W. NEWTON, assistant superintendent of the Magnolia Oil Refinery, Beaumont, Tex., gave a lecture to the engineering students of the Agricultural and Mechanical College, College Station, Tex., recently, on the subject of "Refining Petroleum." The lecture was given under the auspices of the Mid-Continent Oil and Gas Association, and was the fourth of the series.

E. G. RIPPEL has withdrawn from the Buffalo Foundry & Machine Co. and will take an extended rest before engaging in business again. He organized the Buffalo Foundry Co. over 21 years ago and has been largely instrumental in building up the company to its present position. He was largely responsible for the extensive company exhibits at the National Exposition of Chemical Industries and for the large advertising campaigns that characterized the company's publicity plans. Mr. Rippel is succeeded as sales manager by C. W. Pearson, assistant treasurer of the Buffalo Foundry & Machine Co. Mr. Rippel's future plans will be announced later.

L. I. SHAW has resumed his duties as assistant chief chemist of the Bureau of Mines at its Washington office. For several months Mr. Shaw has been on duty at the ceramic station of the bureau at Columbus, Ohio.

Dr. EDWIN E. SLOSSON addressed the recent meeting arranged by the chemical committee of the Chamber of Commerce and by the American Chemical Society, at Rochester, N. Y., on "Relation of Chemistry to a Civic Community."

CHARLES SYER, Norfolk, Va., has been appointed manager of the new sugar refinery of the American Sugar Refining Co. at Baltimore, Md., and will take up his duties at once.

S. W. WILLSON of the Graham Paper Co., St. Louis, Mo., has been appointed a technical adviser of the Bureau of Standards, during the work which the bureau is doing in connection with the standardization and simplification of paper and paper products. Mr. Willson was chief of the pulp and paper division of the War Industries Board during the war.

Obituary

Captain HORACE G. H. TARR, a familiar figure in the waterworks field for the past 50 years, died at his home in Philadelphia, March 2, aged 78 years. At the time of his death he was manager of R. D. Wood & Co., manufacturers of waterworks machinery, Philadelphia, Pa. At the close of the Civil War, through which he served with the Tenth Connecticut Volunteers, Captain Tarr entered the employ of the Brooklyn (N. Y.) Water Department as an inspector of cast-iron pipe. A few years later, as receiver, he operated the Tom Gaylord plant at Newport, Ky. Later he joined the Worthington Pump Co. as salesman. From 1900 until his death he was with R. D. Wood & Co. designing, selling and supervising the erection of waterworks machinery.

JOHN J. VORHEES, president of the Vorhees Rubber Manufacturing Co., Jersey City, N. J., died at his home in that city, Feb. 26, at the age of 75 years. He was connected with the New Jersey Car Spring & Rubber Co. for 28 years, and then organized the company of which he was head.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Petroleum Refining in 1921

On Jan. 1, 1922, there were 303 refineries operating in the United States with a total indicated daily capacity of 1,736,725 bbl., according to the compilation of H. J. Lowe, petroleum economist of the Bureau of Mines. These figures are to be compared with 328 refineries having a daily capacity indicated at 1,714,395 bbl. on Jan. 1, 1921. Operations at the latter date were on the basis of 84 per cent of capacity and on Jan. 1, 1922, at 80 per cent.

The Geological Survey has estimated the production of crude oil in the United States for 1921 at 469,639,000 bbl. and the consumption of domestic and imported petroleum at 525,407,000 bbl. During 1921 the refineries of the United States distilled 75,325,670 bbl. of Mexican crude oil; 2,745,015 bbl. of Mexican tops and 160,557 bbl. of Mexican crude naphtha. The run of Mexican crude exceeded that of 1920 by 19 per cent.

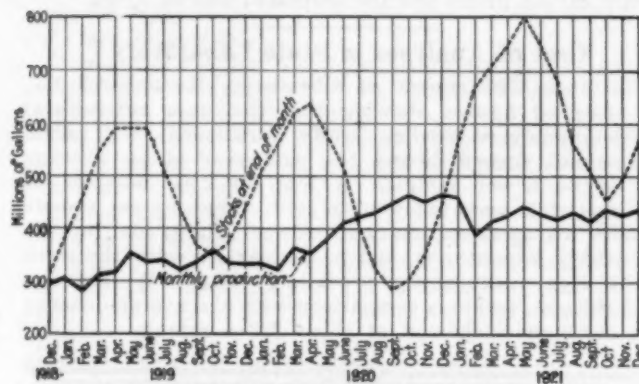


FIG 1—MONTHLY PRODUCTION AND STOCKS OF GASOLINE, 1918-1922.

TABLE I—OUTPUT BY MONTHS OF THE PETROLEUM REFINERIES IN THE UNITED STATES FOR 1921

	Run to the Still Crude Oil (Bbl.)	Other Oils (Bbl.)	Gasoline (Gal.)	Kerosene (Gal.)	Gas and Fuel (Gal.)	Lubricating (Gal.)	Wax (Lb.)	Coke (Tons)	Asphalt (Tons)	Miscellaneous (Gal.)	Losses (Gal.)
January.....	39,637,382	4,206,576	460,432,439	205,374,611	836,684,040	85,908,641	45,659,668	57,961	80,672	145,846,215	1,664,203
February.....	34,588,096	2,942,666	388,188,252	163,081,918	732,542,415	72,432,219	40,384,408	55,029	74,508	120,075,769	1,440,377
March.....	35,509,115	2,788,737	419,795,390	169,247,94	758,334,681	73,003,304	37,719,575	45,475	84,774	85,849,195	1,575,538
April.....	37,594,220	2,363,193	426,215,200	156,156,565	813,144,202	76,456,958	39,200,197	51,386	86,120	96,017,271	1,699,652
May.....	36,990,478	2,823,694	448,567,873	145,225,023	817,367,590	70,000,194	31,441,634	49,891	102,327	84,823,852	1,573,090
June.....	36,940,821	2,740,131	430,344,393	141,637,081	826,355,262	63,088,609	29,860,281	43,567	109,565	100,049,466	1,546,123
July.....	36,040,797	2,649,364	419,641,815	138,724,132	807,428,397	65,893,228	25,070,736	43,496	111,523	83,999,461	1,610,271
August.....	36,044,910	2,705,120	431,577,395	143,652,290	784,450,485	66,473,473	28,498,408	42,602	112,943	92,463,702	1,596,083
September.....	35,613,933	2,999,042	416,913,000	154,017,299	788,408,124	69,053,367	33,054,167	44,863	107,420	83,050,575	1,638,549
October.....	37,968,496	3,727,357	440,955,518	182,453,598	833,775,254	75,971,377	38,264,778	52,368	153,118	93,656,968	1,796,781
November.....	37,211,534	2,956,469	431,886,845	175,240,466	799,256,607	77,005,042	41,574,253	54,338	103,834	86,524,716	1,722,052
December.....	39,222,875	3,590,216	439,031,398	170,315,279	865,769,078	82,572,662	43,159,109	63,489	87,732	130,075,973	1,694,798
Total.....	443,362,657	36,492,565	5,153,549,318	1,945,126,156	9,663,816,135	877,859,074	433,887,214	604,465	1,214,536	1,202,433,163	19,557,517

GASOLINE PRODUCTION

The following figures on the production and consumption of gasoline are of interest in showing its increasing importance:

THE INCOME AND OUTGO OF GASOLINE, 1918-1921

	1921	1920	1919	1918
Income				
Stocks, Jan. 1.....	462,381,837	446,793,431	297,326,983	412,256,833
Production.....	5,153,549,318	4,882,546,649	3,957,857,097	3,570,312,963
Imports.....	37,816,004	46,066,110	8,520,169	12,899,350
Total.....	5,653,747,159	5,375,406,190	4,263,704,249	3,995,469,146
Outgo				
Exports.....	524,279,031	635,247,487	365,883,011	556,422,334
Shipments to Insular Possessions.....	27,368,017	21,348,911	16,217,081	12,209,957
Domestic consumption.....	4,516,012,979	4,256,427,955	3,434,810,726	3,129,509,872
Stocks, Dec. 31.....	586,087,132	462,381,837	446,793,431	297,326,983
Total.....	5,653,747,159	5,375,406,190	4,263,704,249	3,995,469,146

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	157.13
Last week	157.46
March, 1921	157
March, 1920	252
April, 1918 (high)	286
April, 1921 (low)	140

Market developments of the past week have had practically no effect on the index number, which is but one-third of a point lower than last week. The slightly increased prices for ammonium sulphate, barium chloride, caustic soda and citric acid were more than offset by the lower quotations for soda ash and crude cottonseed and linseed oils.

The monthly production during this period as well as the stocks on hand at the end of the month are shown graphically in Fig. 1. Maximum rate of production was reached in October and December of 1920, although the total output for the year was at its maximum in 1921.

Other petroleum products produced by American refineries in 1921 are presented in Table I. The column headed "Miscellaneous" includes the following materials and quantities:

	Gal.		Gal.
Binder.....	18,527,055	Pitch.....	129,800
Flux.....	27,353,495	Residue.....	5,786
Medicinal oils.....	761,008	Slops.....	757,125
Paint products.....	266,220	Tailings.....	180,624
Petrolatum.....	7,250,636	Tar.....	3,374,166
Road oil.....	125,820,652	Topo.....	122,267,027
Roofers' wax.....	66,166	Unfinished.....	227,446,245
Sludge products.....	34,672,612	Wash out.....	25,280
Acid oil.....	2,271,513	Wax tailings.....	3,687,074
Distillates.....	627,570,679		
Total.....		Total.....	1,202,433,163

STOCKS OF GASOLINE

Stocks of gasoline held in storage by American refineries reached 800,495,787 gal. in May, 1921. These are said to be the largest gasoline stocks ever recorded in this country. On Dec. 31, 1921, gasoline in storage had decreased to 586,087,132 gal., which is but little more than 10 per cent of the output for the year. Storage at the end of 1920 was 123,705,000 gal. less than that reported for the last of 1921. The domestic consumption of gasoline for 1921, however, exceeded 1920 by 260,000,000 gal. and 1919 by 1,081,000,000 gal.

The exports and shipments for 1921 amounted to a daily average of 1,511,000 gal. This figure is 283,000 gal. less than the daily average for 1921, but 463,000 gal. in excess of the corresponding figure reported for 1919.

The Causes of Business Failures

The following figures, compiled from reports of Dun's and Bradstreet's and presented in Babson's barometer letter, afford an interesting, quantitative comparison of the different causes of business failures in 1913, 1918, 1920 and 1921:

Cause	1913 Per Cent	1918 Per Cent	1920 Per Cent	1921 Per Cent
Incompetence.....	18.4	26.9	13.3	22.2
Inexperience.....	2.0	4.7	3.3	2.9
Lack of capital.....	24.9	30.8	26.6	21.9
Unwise credits.....	16.0	1.8	3.7	3.9
Failures of others.....	11.4	3.3	0.8	1.8
Extravagance.....	0.6	0.6	0.3	0.3
Neglect.....	0.7	0.9	0.5	0.4
Competition.....	0.9	0.8	0.3	0.3
Specific conditions.....	14.0	19.8	45.5	42.1
Speculation.....	2.7	1.2	1.9	1.1
Fraud.....	8.4	9.2	3.8	3.1
Total.....	100.0	100.0	100.0	100.0
Number of failures.....	15,296	9,657	8,672	19,779

BUSINESS FAILURES IN JANUARY

The largest number of business failures for any month since January, 1915, was reported in January, 1922. As we have previously averred, business mortalities are not necessarily to be regarded as an unfavorable index of future business. Rather they are the result of circumstances which have already passed and in the long run business gains by the elimination of those concerns which cannot compete successfully with the new industrial situation.

Business failures in the chemical and allied industries during January of 1920, 1921 and 1922 are compared with the 1912-13 average in the following table. It will be noted that these industries account for only a relatively small proportion of the total number of failures.

BUSINESS FAILURES IN CHEMICAL AND ALLIED INDUSTRIES

Industry	Number of Failures in January of			Liabilities in Thousands of Dollars		
	1922	1921	1920	Ave. '12-'13	1922	1921
Chemicals and Drugs:						
Manufacturers.....	9	13	3	4	376	392
Dealers.....	64	40	10	50	715	380
Paints and oils:						
Manufacturers.....	1	2	..	3	83	40
Dealers.....	2	6	..	2	40	150
Glass and ceramics:						
Manufacturers.....	10	9	3	11	282	114
Total for all industries	2,723	1,895	569	1,824	73,796	52,137

Du Pont Earnings Greatly Reduced in 1921

The annual report of E. I. du Pont de Nemours & Co. for 1921 shows a net income of \$5,762,417 after inventory adjustment and taxes. When dividends on the debenture stocks were deducted, this is equivalent to \$2.35 per share on its outstanding common stock. This is to be compared with a net income of \$14,563,232, or \$16.96 a share on the common stock in 1920.

President Irene du Pont, in his letter to the stockholders, stated that in his opinion the lower volume of business was directly attributable to the liquidation of inventories. "Of raw materials used in products sold during the first 8 months of 1921," said Mr. Dupont, "approximately one-half came out of the storehouses and one-half was purchased. This means that those who sold to the du Pont company suffered a reduction of 50 per cent in volume of materials needed by this company for its already reduced operations."

"It seems reasonable to suppose that marked reduction in buying has resulted in intense competition to sell and that this has been a large factor in the reduction of prices."

"The most lamentable result of liquidation of inventories has been the discontinuance of employment while inventories were being consumed. Your company has been obliged to discontinue the services of two-thirds of its wage earners and half of its salaried employees."

Corn Products Reports Smaller Income

The Corn Products Refining Co., during the year ended Dec. 31, 1921, earned a net income, after deduction of charges and federal taxes, of \$6,326,358, equivalent, after subtracting preferred dividends, to \$9.21 a share on the outstanding common stock. This compares with a net income of \$12,469,626, or \$21.53 a share, earned in 1920.

New York Market

NEW YORK, March 13, 1922.

The resale market during the past week did not show any signs of increased activity, but large producers have reported a good inquiry for material at the works. Caustic soda was decidedly stronger, as well as the prussiates, barium products, nitrite of soda, sal ammoniac and nitrate of soda. Imported sodium nitrite is very scarce at present and the market is apparently prepared for another sharp advance. The demand for caustic soda for March shipment has kept the market for that commodity in a very firm position. Arsenic, sulphide of soda, oxalic and citric acids have maintained their former levels and leading factors reported moderate inquiries. Caustic potash, cyanide of soda and soda ash were a trifle easier under increased importations and domestic competition.

THE COMMODITY MARKETS

Barium Chloride.—Recent strength reported in the chemical was in evidence at the close of the week and it is doubtful if better than \$62 per ton on spot could be done. The demand remains very good with imported offerings greatly diminished.

Bicarbonate of Soda.—Large producers have shaded regular quotations in a few instances and sales were recorded down to \$1.80 per 100 lb. for barrels, f.o.b. works. Kegs were offered at 24c. per lb. The demand is only moderate.

Bichromate of Soda.—Dealers report small quantity business at 74c. per lb. Producers ask 74c. per lb. for large lots on contract. Some of the leading tanneries have been buying recently and a still better demand is predicted.

Bleaching Powder.—Large drums are offered at 14c. per lb. f.o.b. works, while the imported is quoted at \$1.90 per 100 lb. ex-dock. Competition still remains keen between importers and domestic producers. The demand is somewhat irregular.

Caustic Potash.—Sellers are generally quoting the 88-92 per cent at 54c. per lb. Some resale lots could still be bought at \$5.65 per 100 lb. The demand has not shown any increased activity during the week. Shipment prices are quoted at \$5.75@6.50 per 100 lb.

Caustic Soda.—Dealers report limited offerings of March shipments for export and the market is higher at \$3.65 per 100 lb. There have been some short interests in the market and this has tended to advance prices. Leading producers are of the opinion that remaining March shipments will work to a much higher level. April shipments were offered at \$3.50@3.60 per 100 lb. by dealers. Producers' quotations at the works were unchanged at \$2.50@2.57½ per 100 lb., basis 60 per cent, for carload lots.

Citric Acid.—Prices have shown an advancing tendency, although business has been only of ordinary dimensions. Restricted production abroad has limited offerings considerably on spot and sellers were quoting 45c. per lb., duty paid.

Chlorate of Soda.—Dealers quote the imported at 64c. per lb. Large producers are holding prices on the basis of 7c. per lb., f.o.b. works. The demand is only moderate.

Nitrite of Soda.—Higher prices are recorded for imported and domestic material and it is doubtful if better than 84c. per lb. could be done. Producers quote this price for nearby shipments. The inquiry continues very active with supplies limited.

Oxalic Acid.—Producers report sales on the former basis of 12c. per lb. and report the demand moderately active for regular quantities. Some business has gone through on spot at 13c. per lb.

Prussiate of Potash.—Offerings of this material are not liberal and the market is holding steady at 25½@26c. per lb. on spot. The demand is fairly active from the consuming industries. Red prussiate continues nominal, with March shipments from abroad quoted at 75c. per lb.

COAL-TAR PRODUCTS

Inquiries during the past week have only shown a slight improvement and have tended to place the market in an

irregular condition. Its general tone, however, appears to be toward a gradual expansion in the volume of business. Coal-tar crudes have been brought to rock bottom figures and this has caused a better demand from the consuming industry. Demand for benzene, cresylic acid, toluene and other crude products is steady and the market is being firmly sustained. There have been some recent export orders for alpha-naphthylamine. The available supply of this material appears to be quite limited and very little was obtainable in the open market. Small lots of dimethylaniline were in good demand. Offerings of para-toluidine appeared slightly firmer. Aniline oil is showing a better tone with a moderate improvement from consuming channels. Producers report a lower market for H acid.

Benzene.—There has been no let-up from the firm position of this crude. The demand continues active both on domestic and foreign account and producers report a heavily sold condition. Resale lots are very scarce and the market is nominally quoted at 35c. per gal. for the 90 per cent grade.

Naphthalene.—Sales of flakes are reported by makers at 6½c. per lb. Balls are moving quietly through first-hand channels at 8c. per lb., while odd lots have been sold a fraction under this figure. Crushed material is quoted at 6@6½c. per lb. The demand should be better at this season of the year.

The Chicago Market

CHICAGO, March 9, 1922.

No noteworthy changes occurred in the industrial chemical market during the past 2 weeks. Factors in this field report a fair volume of small orders and a good inquiry for prices. Competition is still very keen and a large request will usually bring out prices lower than the schedule. However, this tendency to cut is becoming less marked, especially on material of foreign origin where the replacement cost is considerably higher than the present spot market.

GENERAL CHEMICALS

The alkali market is unchanged as to price and the consuming demand remains light. Solid caustic soda is quoted at \$3.75 per 100 lb. and the ground at \$4.50, both prices being for ton lots with the material delivered to the consumer's plant. Caustic potash is exhibiting signs of strength and 6½c. per lb. was the rock bottom for ordinary lots to be delivered from spot stocks. Soda ash is moving in a routine way and is available at \$2.30 per 100 lb. for material in coopeage.

Potash alum is rather scarce and whatever spot material is available is being quoted at 6c. per lb. for lumps and 7c. for powdered. White arsenic is still firm and is quoted somewhat higher at 8½@9c. per lb. Blue vitriol is in fair request with \$5.90 per 100 lb. the inside for small or medium quantities. Copperas is also in good demand and is quoted at \$1.75 per lb., single barrel lots. Carbon bisulphide is slightly easier and 6½c. could probably be done on a fair-sized lot. Carbon tetrachloride is quiet and spot supplies could be had at 10½c. per lb., large drums extra. Formaldehyde is moving fairly well and at the present price of 10c. per lb. should be an attractive proposition. Competition has forced refiners of c.p. glycerine to lower their prices, the new schedule being 16c. per lb., bulk basis.

Bichromates are unchanged as to price although the movement is restricted to very small lots. Potassium bichromate is quoted at 11½c. per lb., single cask lots, and sodium at 9@9½c., depending on the quantity and seller. Red prussiate of potash is still off of the spot market and as far as could be determined none is near by. Yellow prussiate of potash is very firm and is moving well at 27@28c. per lb. Sodium fluoride is attracting a little attention and is unchanged at 11c. per lb. for small or medium-sized lots.

Commercial furfural, reported for the first time in our letter of March 1, is still quoted at 50c. per lb. for quantities in excess of 100 lb. Rumors that imported furfural was available in the Eastern markets have not yet been confirmed.

The Iron and Steel Market

PITTSBURGH, March 10, 1922.

Production of steel ingots, which is an accurate and prompt reflection of the volume of steel demand when buying is for prompt shipment, has been practically stationary since the end of January, at a rate of about 29,000,000 tons per annum. During January and February there was a remarkably rapid increase. The American Iron and Steel Institute's reports of monthly production of thirty steel companies indicate that the annual rate at which the whole industry operated was as follows: In November, 23,300,000 tons; December, 19,750,000 tons; January, 22,750,000; February, 26,850,000 tons. These are approximations, with a probable error of less than half a million tons. The rate at the end of December was probably under 17,000,000 tons, while the rate in the past fortnight has been about 29,000,000 tons, an increase of 70 per cent or more.

The future would be discovered if the exact cause or causes of this increase in 2 months could be ascertained. "General conditions" or "underlying conditions" will not explain it, though it will explain a part. Liquidation of stocks will not explain it, for such liquidation was practically completed by Oct. 1, and a 23,000,000-ton rate of ingot production followed, for 2 months. The season of the year will not fully explain it, unless one is prepared to believe that when spring has actually arrived production will be much larger still. If all the buying has been of a strictly hand-to-mouth character, by far the heaviest demand is still to come.

Steel prices may furnish part of the explanation, particularly as we have an incident that may be illuminating. A few days ago the Jones & Laughlin Steel Co., one of the large independents, advanced its price on bars, shapes and plates to 1.50c. The market has been quotable at 1.35@1.50c. Previous to this withdrawal from the market, for that of course is what the action amounts to, the company is understood to have accumulated enough orders to carry it with its present operating rate for about 60 days. Perhaps the very low prices, well below what were expected to develop, influenced buyers to provide for the future to a certain extent.

The total demand has been practically constant in the past fortnight, as indicated by the steel ingot production rate. The only conspicuous absentee from the steel market has been the agricultural implement trade, and it has lately been buying a little steel to piece out its stocks preparatory to resumption of manufacturing in a modest way.

Sheet prices continue to be firmly held at 3c. for black and 4c. for galvanized, the rigid continuance of these prices for more than 3 months being the phenomenon of the steel market. Wire nails appear steady at the recent decline to \$2.40, but there are rumors of less having been done. There is much talk of shading in standard steel pipe, but it is a fact that much business is done at substantially the regular prices. Tin plate is steady at \$4.75 per base box, concessions on moderately large lots being usually 10 or 15 cents.

PIG IRON AND COKE

On the whole the pig-iron markets are steady if not actually stiffening. Prices are reported a trifle better at Birmingham, Chicago and Philadelphia, while the local market is unchanged at \$19@19.50 for bessemer, \$17.75 @ \$18 for basic and \$18.75@19 for foundry, f.o.b. valley furnaces, freight to Pittsburgh being \$1.96.

Lake Superior iron ore is likely to come down at least \$1 a ton for the 1922 season. Shippers consider it practically certain that the rail rate from the Mesabi range to upper lake dock will be reduced from \$1 to 75c. before the opening of navigation. The vessel rate will doubtless come down somewhat. It was 94c. last season, 14c. being paid by vessel to lower lake dock, leaving 80c. net. As prices are f.o.b. Lake Erie dock, these declines will affect the market price of ore, the ore shippers themselves standing some reduction at mine.

Connellsville coke has been holding its recent 50-cent advance, spot and prompt being \$3.25@3.50 for furnace and \$4.25@4.75 for foundry.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.		\$0.40 - \$0.42
Acetone.....lb.	\$0.11 - \$0.12	.12 - .12
Acid, acetic, 28 per cent.....100 lbs.	2.50 - 2.60	2.65 - 3.00
Acetic, 56 per cent.....100 lbs.	5.00 - 5.25	5.30 - 5.50
Acetic, glacial, 99 1/2 per cent, carboys, 100 lbs.	9.00 - 9.50	9.75 - 10.00
Boric, crystals.....lb.	.11 - .11 1/2	.11 - .12
Boric, powder.....lb.	.11 - .11 1/2	.11 - .12
Citric.....lb.		.45 - .46
Hydrochloric.....100 lb.	1.15 - 1.25	1.30 - 1.75
Hydrofluoric, 52 per cent.....lb.	.11 - .11 1/2	.11 - .12
Lactic, 44 per cent tech.....lb.	.09 - .10	.10 - .12
Lactic, 22 per cent tech.....lb.	.04 - .04 1/2	.04 - .05
Molybdic, e.p.....lb.	3.00 - 3.25	3.30 - 3.75
Muriatic, 20 deg. (see hydrochloric).....lb.		
Nitric, 40 deg.....lb.	.06 - .06 1/2	.06 - .07
Nitric, 42 deg.....lb.	.06 - .07	.07 - .07 1/2
Oxalic, crystals.....lb.	.12 - .12 1/2	.13 - .14
Phosphoric, 50 per cent solution.....lb.	.08 - .08 1/2	.08 - .09
Picric.....lb.	.20 - .25	.27 - .35
Pyrogallol, resublimed.....lb.		1.65 - 1.75
Sulphuric, 60 deg., tank cars.....ton	10.00 - 11.00	
Sulphuric, 60 deg., drums.....ton	12.00 - 14.00	
Sulphuric, 66 deg., tank cars.....ton	16.00 - 16.50	
Sulphuric, 66 deg., drums.....ton	20.00 - 20.50	21.00 - 22.00
Sulphuric, 66 deg., carboys.....ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	19.50 - 20.00	
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	22.00 - 22.50	23.00 - 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. P.....lb.		.60 - .75
Tannic (tech.).....lb.	.40 - .45	.46 - .50
Tartaric, imported crystals.....lb.		.25 - .26
Tartaric acid, imported, powdered.....lb.		.26 - .29
Tartaric acid, domestic.....lb.		.30
Tungstic, per lb. of WO.....lb.		1.00 - 1.10
Alcohol, ethyl.....gal.		4.75 - 5.50
Alcohol, methyl (see methanol)		
Alcohol, denatured, 188 proof No. 1.....gal.		.34 - .36
Alcohol, denatured, 188 proof No. 5.....gal.		.34 - .36
Alum, ammonia, lump.....lb.	.03 - .03 1/2	.04 - .04 1/2
Alum, potash, lump.....lb.	.03 - .03 1/2	.03 - .04
Alum, chrome, lump.....lb.	.07 - .08	.08 - .08 1/2
Aluminium sulphate, commercial, 100 lb.	1.65 - 1.85	1.90 - 2.40
Aluminium sulphate, iron free.....lb.	.02 - .02 1/2	.03 - .03 1/2
Aqua ammonia, 26 deg. (750 lb.).....lb.	.07 - .07 1/2	.08 - .08 1/2
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 - .30 1/2	.31 - .33
Ammonium carbonate, powder.....lb.	.07 - .07 1/2	.08 - .09
Ammonium nitrate.....lb.	.06 - .07	.07 - .07 1/2
Amylacetate tech.....gal.		2.00 - 2.40
Arsenic, white, powdered.....lb.	.07 - .07 1/2	.07 - .08
Arsenic, red, powdered.....lb.	.12 - .12 1/2	.12 - .13
Barium chloride.....ton	62.00 - 64.00	65.00 - 70.00
Barium dioxide (peroxide).....lb.	.20 - .21	.21 - .22
Barium nitrate.....lb.	.06 - .07	.07 - .08 1/2
Barium sulphate (precip.) (blanc fixe).....lb.	.03 - .04	.04 - .04 1/2
Blanc fixe, dry.....lb.	.04 - .04 1/2	
Blanc fixe, pulp.....ton	45.00 - 55.00	
Bleaching powder.....100 lb.	1.75 - 2.00	2.05 - 3.00
Blue vitriol (see copper sulphate).....lb.		
Borax.....lb.	.05 - .05 1/2	.06 - .06 1/2
Brimstone (see sulphur, roll).....lb.		
Bromine.....lb.	.20 - .21	.21 - .26
Calcium acetate.....100 lbs.	1.75 - 2.00	
Calcium carbide.....lb.	.04 - .04 1/2	.05 - .05 1/2
Calcium chloride, fused, lump.....ton	24.00 - 24.50	24.75 - 27.00
Calcium chloride, granulated.....lb.	.01 - .02	.02 - .02 1/2
Calcium peroxide.....lb.		1.40 - 1.50
Calcium phosphate, tribasic.....lb.		.15 - .16
Camphor.....lb.		.90 - .92
Carbon bisulphide.....lb.	.06 - .06 1/2	.06 - .07 1/2
Carbon tetrachloride, drums.....lb.	.10 - .10 1/2	.11 - .12
Carbonyl chloride, (phosgene).....lb.		.60 - .75
Caustic potash (see potassium hydroxide).....lb.		
Caustic soda (see sodium hydroxide).....lb.		
Chalk, precip.—domestic, light.....lb.	.04 - .04 1/2	
Chalk, precip.—domestic, heavy.....lb.	.03 - .03 1/2	
Chalk, precip.—imported, light.....lb.	.04 - .05	
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.06 - .06 1/2	.06 - .07
Chloroform.....lb.		.37 - .40
Cobalt oxide.....lb.		2.00 - 2.10
Copperas.....ton	15.00 - 16.00	16.50 - 30.00
Copper carbonate, green precipitate.....lb.	.19 - .20	.20 - .21
Copper cyanide.....lb.		.58 - .60
Copper sulphate, crystals.....100 lb.	5.55 - 5.65	5.70 - 6.25
Cream of tartar.....lb.		.23 - .25
Epsom salt (see magnesium sulphate).....gal.		.60 - .65
Ethyl acetate com. 85%.....gal.		.93 - 1.00
Ethyl acetate, pure (acetic ether, 96% to 100%).....gal.		.93 - 1.00
Formaldehyde, 40 per cent.....gal.	.09 - .09 1/2	.09 - .10 1/2
Fullers earth, f.o.b. mines.....net ton	16.00 - 17.00	
Fullers earth—imported powdered—net ton	30.00 - 32.00	
Fusel oil, ref.....gal.		2.50 - 3.00
Fusel oil, crude.....gal.		1.40 - 1.75
Glauber's salt (see sodium sulphate).....lb.		.16 - .17
Glycerine, e.p. (see extra).....lb.		4.05 - 4.15
Iodine, resublimed.....lb.		.12 - .18
Iron oxide, red.....lb.		.09 - .11 1/2
Lead acetate.....lb.	.15 - .15 1/2	.15 - .16 1/2
Lead arsenate, powd.....lb.		.15 - .20
Lead nitrate.....lb.	.07 - .07 1/2	.08 - .08 1/2
Litharge.....lb.	.06 - .06 1/2	.06 - .08
Magnesium carbonate, technical.....lb.	2.65 - 2.70	2.75 - 3.00
Magnesium sulphate, U. S. P.....100 lb.		1.00 - 1.80
Magnesium sulphate, technical.....100 lb.		.57 - .58
Methanol, 95%.....gal.		.59 - .60
Methanol, 97%.....gal.		.11 - .11 1/2
Nickel salt, double.....lb.		.11 - .11 1/2
Nickel salt, single.....lb.		.45 - .46
Phosgene (see carbonyl chloride).....lb.		.47 - .50
Phosphorus, red.....lb.		.47 - .50
Phosphorus, yellow.....lb.		.37 - .35

	Carlots	Less Carlots
Potassium dichromate.....lb.	.10 - .10 1/2	.10 - .10 1/2
Potassium bromide, granular.....lb.	.15 - .20	.15 - .20
Potassium carbonate, U. S. P.....lb.	.12 - .12 1/2	.13 - .16
Potassium carbonate, 80-85%.....lb.	.04 - .04 1/2	.04 - .05 1/2
Potassium chlorate, crystals.....lb.	.05 - .06	.06 - .08
Potassium cyanide.....lb.		.42 - .45
Potassium hydroxide (caustic potash).....100 lb.	5.65 - 5.75	5.80 - 6.50
Potassium iodide.....lb.		3.10 - 3.15
Potassium nitrate.....lb.	.07 - .07 1/2	.08 - .09
Potassium permanganate.....lb.	.13 - .14	.14 - .22
Potassium prussiate, red.....lb.	nominal	nominal
Potassium prussiate, yellow.....lb.	.25 - .26	.26 - .26 1/2
Rochelle salts (see sodium potas tartrate).....lb.		
Salammoniac, white, granular.....lb.	.07 - .07 1/2	.07 - .08
Salammoniac, gray, granular.....lb.	.07 - .07 1/2	.07 - .08
Salsoda.....100 lb.	1.60 - 1.70	1.75 - 2.00
Salt cake (bulk).....ton	17.00 - 20.00	
Soda ash, light.....100 lb.	1.75 - 1.90	1.95 - 2.50
Soda ash, dense.....100 lb.	1.85 - 1.95	2.00 - 2.50
Sodium acetate.....lb.	.04 - .04 1/2	.04 - .05
Sodium bicarbonate.....100 lb.	2.10 - 2.15	2.20 - 2.50
Sodium bichromate.....lb.	.07 - .08	.08 - .08 1/2
Sodium bisulphate (nitre cake).....ton	4.50 - 4.60	4.65 - 5.50
Sodium bisulphate powdered, U.S.P.....lb.	.04 - .04 1/2	.04 - .05 1/2
Sodium chloride.....lb.	.06 - .07	.07 - .07 1/2
Sodium chloride, long.....ton	12.00 - 13.00	
Sodium cyanide.....lb.	.22 - .26	.26 - .27 1/2
Sodium fluoride.....lb.	.09 - .10	.10 - .11
Sodium hydroxide (caustic soda).....100 lb.	3.65 - 3.70	3.75 - 4.25
Sodium hyposulphite.....lb.	.03 - .03 1/2	.03 - .04
Sodium nitrite.....lb.	.08 - .08 1/2	.09 - .09 1/2
Sodium peroxide, powdered.....lb.	.28 - .30	.31 - .35
Sodium phosphate, dibasic.....lb.	.03 - .04	.04 - .04 1/2
Sodium potassium tartrate (Rochelle salts).....lb.	.18 - .18 1/2	.18 - .21
Sodium prussiate, yellow.....lb.	.18 - .18 1/2	.18 - .19
Sodium silicate, solution (40 deg.).....100 lb.	.85 - 1.00	1.05 - 1.15
Sodium silicate, solution (60 deg.).....100 lb.	2.50 - 2.60	2.65 - 3.00
Sodium sulphate crystals (glaubers salt) 100 lb.	1.15 - 1.25	1.30 - 1.90
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.04 - .04 1/2	.04 - .05
Sodium sulphite, crystals.....lb.	.03 - .03 1/2	.03 - .03 1/2
Strontium nitrate, powdered.....lb.	.10 - .11	.11 - .15
Sulphur chloride, yellow.....lb.	.04 - .05	.05 - .06
Sulphur, crude.....ton	18.00 - 20.00	
Sulphur dioxide, liquid, cylinders extra.....lb.	.08 - .08 1/2	.09 - .10
Sulphur (sublimed), flour.....100 lb.		2.25 - 3.10
Sulphur, roll (brimstone).....100 lb.		2.00 - 2.75
Talc—imported.....ton	30.00 - 40.00	
Talc—domestic powdered.....ton	18.00 - 25.00	
Tin bichloride.....lb.	.09 - .09 1/2	.09 - .10
Tin oxide.....lb.		.39 - .40
Zinc carbonate.....lb.	.14 - .14 1/2	.14 - .15 1/2
Zinc chloride, gran.....lb.	.07 - .08	.08 - .08 1/2
Zinc cyanide.....lb.	.42 - .44	.45 - .47
Zinc oxide, XX.....lb.	.07 - .08	.08 - .08 1/2
Zinc sulphate.....100 lb.	2.75 - 3.00	3.05 - 3.30

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude.....lb.	\$1.00 - \$1.05
Alpha-naphthol, refined.....lb.	1.10 - 1.15
Alpha-naphthylamine.....lb.	.30 - .31
Aniline oil, drums extra.....lb.	.16 - .17
Aniline salts.....lb.	.24 - .26
Anthracene, 80% n drums (100 lb.).....lb.	.75 - 1.00
Benzaldehyde U.S.P.....lb.	1.25 - 1.30
Benzidine, base.....lb.	.85 - .95
Benzidine sulphate.....lb.	.75 - .85
Benzoic acid, U.S.P.....lb.	.60 - .65
Benzoate of soda, U.S.P.....lb.	.55 - .57
Benzene, pure, water-white, in drums (100 gal.).....gal.	.29 - .35
Benzene, 90%, in drums (100 gal.).....gal.	.27 - .32
Benzyl chloride, 95-97%, refined.....lb.	.25 - .27
Benzyl chloride, tech.....lb.	.20 - .23
Beta-naphthol benzoate.....lb.	3.75 - 4.00
Beta-naphthol, sublimed.....lb.	.60 - .65
Beta-naphthol, tech.....lb.	.27 - .30
Beta-naphthylamine, sublimed.....lb.	1.50 - 1.60
Cresol, U. S. P., in drums (100 lb.).....lb.	.12 - .15
Ortho-cresol, in drums (100 lb.).....lb.	.16 - .18
Cresylic acid, 97-99%, straw color, in drums.....gal.	.50 - .52
Cresylic acid, 25-97%, dark, in drums.....gal.	.45 - .47
Dichlorobenzene.....lb.	.06 - .09
Diethylaniline.....lb.	1.10 - 1.15
Dimethylaniline.....lb.	.38 - .40
Dinitrobenzene.....lb.	.22 - .25
Dinitrochlorobenzene.....lb.	.23 - .25
Dinitronaphthalene.....lb.	.32 - .35
Dinitrophenol.....lb.	.35 - .38
Dinitrotoluene.....lb.	.22 - .24
Dip oil, 25%, car lots, in drums.....gal.	.24 - .26
Diphenylamine.....lb.	.59 - .70
H-acid.....lb.	.85 - 1.00
Meta-phenylenediamine.....lb.	.90 - 1.00
Monochlorobenzene.....lb.	.14 - .15
Monothylaniline.....lb.	1.20 - 1.25
Naphthalene crushed, in bbls.....lb.	.06 - .06 1/2
Naphthalene, flake.....lb.	.06 - .07
Naphthalene, balls.....lb.	.08 - .08 1/2
Naphthionic acid, crude.....lb.	.65 - .70
Nitrobenzene.....lb.	.10 - .12
Nitronaphthalene.....lb.	.30 - .35
Nitro-toluene.....lb.	.15 - .17 1/2
Ortho-amidophenol.....lb.	2.75 - 2.80
Ortho-dichlorobenzene.....lb.	.15 - .20
Ortho-nitro-phenol.....lb.	.75 - .80
Ortho-nitro-toluene.....lb.	.15 - .20
Ortho-toluidine.....lb.	.20 - .25
Para-amidophenol, base.....lb.	1.25 - 1.30
Para-amidophenol, HCl.....lb.	1.30 - 1.35
Para-dichlorobenzene.....lb.	.15 - .18
Paranitroaniline.....lb.	.75 - .77
Para-nitrotoluene.....lb.	.70 - .75
Para-phenylenediamine.....lb.	1.50 - 1.55
Para-toluidine.....lb.	1.10 - 1.15
Phthalic anhydride.....lb.	.35 - .38

Phenol, U. S. P., drums.....	lb.	.11	—	15
Pyridine.....	gal	1.75	—	2.75
Resorcinol, technical.....	lb.	1.25	—	1.30
Resorcinol, pure.....	lb.	1.80	—	1.95
Salicylic acid, tech., in bbls.....	lb.	.20	—	.21
Salicylic acid, U. S. P.....	lb.	.22	—	.23
Salol.....	lb.	.80	—	.82
Solvent naphtha, water-white, in drums, 100 gal.....	gal.	.25	—	.28
Solvent naphtha, crude, heavy, in drums, 100 gal.....	gal.	.12	—	.14
Sulphanilic acid, crude.....	lb.	.25	—	.27
Tolidine.....	lb.	1.20	—	1.30
Toluidine, mixed.....	lb.	.32	—	.38
Toluene, in tank cars.....	gal.	.25	—	.28
Toluene, in drums.....	gal.	.30	—	.35
Xylidines, drums, 100 gal.....	lb.	.40	—	.45
Xylene, pure, in drums.....	gal.	.40	—	.45
Xylene, pure, in tank cars.....	gal.	.45	—	.55
Xylene, commercial, in drums, 100 gal.....	gal.	.33	—	.35
Xylene, commercial, in tank cars.....	gal.	.30	—	....

Waxes

Prices remain same as March 8th report.

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.....	280 lb.	\$5.25	—	5.30
Rosin E-I.....	280 lb.	5.35	—	5.40
Rosin K-N.....	280 lb.	6.00	—	6.75
Rosin W. G.-W. W.....	280 lb.	7.00	—	7.25
Wood rosin, bbl.....	280 lb.	6.25	—	....
Spirits of turpentine.....	gal.	.88	—	....
Wood turpentine, steam dist.....	gal.	.85	—	....
Wood turpentine, dest. dist.....	gal.	.70	—	.80
Pine tar pitch, bbl.....	200 lb.	....	—	6.00
Tar, kiln burned, bbl. (500 lb.).....	bbl.	....	—	9.50
Retort tar, bbl.....	500 lb.	....	—	9.00
Rosin oil, first run.....	gal.	.36	—	....
Rosin oil, second run.....	gal.	.38	—	....
Rosin oil, third run.....	gal.	.46	—	....
Pine oil, steam dist., sp.gr., 0.930-0.940.....	gal.	1.90	—	....
Pine oil, pure, dest. dist.....	gal.	1.50	—	....
Pine tar oil, ref., sp.gr. 1.025-1.035.....	gal.	.46	—	....
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.....	gal.	.35	—	....
Pine tar oil, double ref., sp.gr. 0.965-0.990.....	gal.	.75	—	....
Pine tar, ref., thin, sp.gr., 1.080-1.060.....	gal.	.35	—	....
Turpentine, crude, sp. gr. 0.900-0.970.....	gal.	1.25	—	....
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990.....	gal.	.35	—	....
Pinewood creosote, ref.....	gal.	.52	—	....

Fertilizers

Ammonium Sulphate, Bulk and F.A.S., 100 lb....	\$3.00-\$3.15
Nitrate of Soda, 100 lb.....	2.80- 2.85

All other prices remain quotably unchanged.

Crude Rubber

Para-Upriver fine.....	lb.	\$0.171	—	.171
Upriver coarse.....	lb.	.13	—	.131
Upriver caucho ball.....	lb.	.13	—	.131
Plantation—First latex crepe.....	lb.	.141	—	.15
Ribbed smoked sheets.....	lb.	.15	—	.15
Brown crepe, thin, clean.....	lb.	.13	—	....
Amber crepe No. 1.....	lb.	.15	—	....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.....	lb.	\$0.10	—	\$0.104
Castor oil, AA, in bbls.....	lb.	.11	—	.12
China wood oil, in bbls.....	lb.	.14	—	.144
Coconut oil, Ceylon grade, in bbls.....	lb.	.091	—	.094
Coconut oil, Cochinchina grade, in bbls.....	lb.	.091	—	.10
Corn oil, crude, in bbls.....	lb.	.11	—	.111
Cottonseed oil, crude (f. o. b. mill).....	lb.	.10	—	.104
Cottonseed oil, summer yellow.....	lb.	.11	—	.12
Cottonseed oil, winter yellow.....	lb.	.13	—	.134
Linseed oil, raw, car lots (domestic).....	gal.	.84	—	.85
Linseed oil, raw, tank cars (domestic).....	gal.	.80	—	.81
Linseed oil, in 5-bbl lots (domestic).....	gal.	.87	—	.89
Olive oil, denatured.....	gal.	1.15	—	1.20
Palm, Lagos.....	lb.	.08	—	.084
Palm, Niger.....	lb.	.06	—	.064
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.10	—	.104
Peanut oil, refined, in bbls.....	lb.	.13	—	.134
Rapeseed oil, refined in bbls.....	gal.	.86	—	.87
Rapeseed oil, blown, in bbls.....	gal.	.88	—	.89
Soya bean oil (Manchurian), in bbls, N. Y.....	lb.	.11	—	....
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.091	—	....

FISH

Light pressed menhaden.....	gal.	\$0.54	—	....
Yellow bleached menhaden.....	gal.	.57	—	....
White bleached menhaden.....	gal.	.56	—	....
Blown menhaden.....	gal.	.61	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. mills.....	net ton	17.00	—	23.00
Barytes, ground, off color f.o.b. mills.....	net ton	13.00	—	21.00
Barytes, floated, f.o.b. St. Louis.....	net ton	23.00	—	24.00
Barytes, crude f.o.b. mines.....	net ton	6.00	—	7.00
Casein.....	lb.	.101	—	.12
Shellac, orange fine.....	lb.	.78	—	.784
Shellac, orange superfine.....	lb.	.80	—	.81
Shellac, A. C. garnet.....	lb.	.63	—	.64
Shellac, T. N.....	lb.	.76	—	.77

All other prices remain unchanged.

Refractories

Prices same as previous report.

Ferro-Alloys

All f.o.b. Works

Ferrocobalt-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrocobalt, per lb. of Cr contained, 6-8% carbon, carlots.....	lb.	.11	—	....
Ferrocobalt, per lb. of Cr contained, 4-6% carbon, carlots.....	lb.	.12	—	....
Ferromanganese, 76-80% Mn, domestic.....	gross ton	59.00	—	60.00
Ferromanganese, 78-82% Mn, English and German c.i.f. Atlantic seaport.....	gross ton	58.00	—	62.50
Spiegeleisen, 18-22% Mn.....	gross ton	30.00	—	32.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.25	—	....
Ferrosilicon, 10-15%.....	gross ton	38.00	—	40.00
Ferrosilicon, 50%.....	gross ton	54.00	—	55.00
Ferrosilicon, 75%.....	gross ton	115.00	—	120.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.37	—	.50
Ferro-uranium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	....
Ferrovanadium, 30-40% per lb. of contained V.....	lb.	3.55	—	3.75

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	net ton	\$6.00	—	\$12.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	ton	19.00	—	20.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	ton	19.00	—	20.00
Coke, foundry, f.o.b. ovens.....	net ton	4.00	—	4.25
Coke, furnace, f.o.b. ovens.....	net ton	3.25	—	3.50
Fluorspar, gravel, f.o.b. mines, New Mexico.....	net ton	12.00	—	....
Fluorspar, standard, domestic washed gravel.....	net ton	20.00	—	22.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.011	—	.014
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.24	—	.25
Manganese ore, chemical (MnO ₂).....	net ton	55.00	—	60.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.45	—	.45
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	27.00	—	....
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.12	—	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.13	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.11	—	.12
Rutile, 95% TiO ₂ , per lb. ore.....	lb.	.12	—	....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.00	—	2.25
Tungsten, wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	2.00	—	2.25
Uranium ore (carnotite) per lb. of U ₂ O ₅	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U ₂ O ₅	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00	—	....
Zircon, washed, iron free, f.o.b. Pablo, Florida.....	lb.	.041	—	.131

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12.90
Aluminum, 98 to 99 per cent.....	19.00
Antimony, wholesale lots, Chinese and Japanese.....	4.25
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Nickel, electrolytic, resale.....	32.00
Monel metal, shot and blocks.....	35.00
Monel metal, ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, Straits.....	29.00
Lead, New York, spot.....	4.70
Lead, E. St. Louis, spot.....	4.40
Zinc, spot, New York.....	5.10
Zinc, spot, E. St. Louis.....	4.65

OTHER METALS

Silver (commercial).....	oz.	\$0.64
Cadmium.....	lb.	1.00-1.10
Bismuth (500 lb. lots).....	lb.	2.00@2.10
Cobalt.....	lb.	3.00@3.25
Magnesium.....	lb.	1.15
Platinum.....	oz.	85.00@ 90.00
Iridium.....	oz.	170.00@190.00
Palladium.....	oz.	55.00@ 60.00
Mercury.....	.75 lb.	50.00

Finished metals, old metals and structural material quotations remain unchanged.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

ALTON—The Russell Clay Mfg. Co., Baltimore, Md., recently organized under Delaware laws, has acquired property at Alton, near Birmingham, for the operation of a new plant for the manufacture of vitrified paving brick and other burned clay products. It is planned to begin operations early in April, developing a capacity of about 50,000 bricks per day. The company is headed by L. S. Russell. Floyd B. Powell, Equitable Bldg., Baltimore, is manager.

CHOCTAW POINT—The Republic Creosoting Co. is planning for the rebuilding of the portion of its plant recently damaged by fire with loss estimated at about \$12,000.

Arkansas

WALNUT RIDGE—The Industrial Bureau of the local Chamber of Commerce is perfecting plans for the establishment of a leather-tanning plant.

FORT SMITH—The Choctaw Brick & Gas Co., Kennedy Bldg., has acquired property at Mansfield, Ark., for the establishment of a plant for the manufacture of brick, tile and other burned clay products. Allen Kennedy is secretary.

California

RICHMOND—The Galena Signal Oil Co., Franklin, Pa., has acquired property at Richmond, comprising about 4 acres of land, near the works of the Standard Oil Co., for the erection of a new oil-refining plant, estimated to cost about \$500,000. Construction will be commenced at an early date. Charles A. Miller, superintendent of the Franklin refinery, will be in charge of erection.

VERNON—The Pacific Petroleum Products Co. is planning for the rebuilding of the portion of its plant destroyed by fire, Feb. 16, with loss estimated at about \$25,000.

LOS ANGELES—The Los Angeles Gas & Electric Co., 645 South Hill St., has had plans prepared for the erection of a 1-story compressor plant, 77 x 150 ft., on Center St., near Jackson St., to cost about \$60,000, including machinery.

SAN FRANCISCO—The Los Angeles Soap Co., Los Angeles, has plans under way for the erection of a new 3-story and basement soap manufacturing plant, 100 x 160 ft., at 2nd and Brannan Sts., San Francisco, to cost about \$150,000, including machinery. W. H. Crim, 425 Kearny St., San Francisco, is architect.

ALTURAS—The Stockton Match Co., Stockton, Cal., has acquired property at Alturas, as a site for the erection of a new plant. Plans will be prepared at an early date.

Delaware

WILMINGTON—The National Fibre & Insulation Co. has closed negotiations for the purchase of the plant and business of the American Vulcanized Fibre Co., Wilmington, Del., with branch factory at Newark, Del. The purchasing company will continue the operation of its present plant and headquarters at Yorklyn, Del., and will use the acquired plants as branches. General expansion in operation is planned. J. Warren Miller is president of the National company.

Florida

HAIALEAH—The Hialeah Producing & Refining Co., 25 Second Ave., Miami, Fla., is planning for the erection of a new oil refinery at Hialeah, near Miami, to cost about \$200,000. It will be equipped for an initial output of approximately 1,000 bbl. per day. E. D. Noe is president.

Georgia

AUGUSTA—The Dunbar Brick Co. is planning for the rebuilding of the portion of its plant recently destroyed by fire with loss estimated at about \$20,000. H. H. Stafford is head.

Idaho

KELLOGG—The Bunker Hill & Sullivan Mining Co. will build a new electrolytic zinc plant addition to its local plant, estimated to cost about \$1,000,000, including machinery. It is expected to require about 24 months to complete the mill.

Illinois

MATTESON—The Mid-West Box Co., 111 West Washington St., Chicago, Ill., has preliminary plans under way for the erection of a new chemical plant at Matteson, to be 3-story, 60 x 140 ft., estimated to cost about \$300,000, including equipment. K. I. Herman, company address, is in charge. Harvey C. Miller, 112 West Adams St., Chicago, is architect.

CHICAGO—Ludwig & Ludwig, 1611 North Lincoln St., are planning for the erection of a 2-story addition, 25 x 65 ft., to their leather tannery, estimated to cost about \$25,000. Axel V. Teisen, 4804 North Kedzie Ave., is architect.

Indiana

COLUMBUS—With the dismissal of the receiver for the Indiana Oil Refining Co. and the return of the property to the company, plans are being arranged for the completion of its new oil-refining plant on property to the south of the city limits. The work is estimated to cost about \$75,000. It is expected to have the refinery ready for service in about 60 days. Louis J. Scheidt is president.

FAIRMOUNT—The Fairmount Paper Products Co. will soon begin the erection of a new plant on Adams St., for the manufacture of paper specialties of various kinds. Harry Dwyer, Marion, Ind., is president and general manager.

VALPARAISO—The Chesterton China Co. is completing the erection of a new plant and plans to begin service in a portion of the works at an early date. Two of five kilns have been completed. It is expected to have the entire plant ready for capacity production early in the summer, giving employment to about 500 persons.

Iowa

FIGART—The Harblson-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa., has preliminary plans under consideration for the construction of a new plant at Figart, for the manufacture of firebrick and other refractories.

Kansas

COFFEYVILLE—The Sinclair Refining Co., 111 West Washington St., Chicago, Ill., will proceed at once with the erection of its new local oil refinery, upon which work was temporarily discontinued recently owing to labor difficulties. The company has arranged an appropriation of \$3,000,000 for work on the refinery and affiliated structures during the present year.

Kentucky

LOUISVILLE—The Peaslee-Gaulbert Co., 15th and High Sts., manufacturer of paints, varnishes, etc., is planning for the erection of a plant addition to cost about \$100,000, including equipment.

Louisiana

LAFAYETTE—The Benners Salt Co. has been reorganized under the name of the Lafayette Salt Co., with increase in capital to \$500,000. The company plans for expansion at its plant at Anse La Butte, La., and will install equipment for increased production. J. J. Kean is manager.

Maine

BRIDGTON—The Simes Leather Co. has acquired the local tanning plant of A. G. Walton & Co., which has been closed for about 5 years. The new owner will remodel and improve the tannery, and plans to commence production at an early date. The former capacity will be increased.

Maryland

BALTIMORE—The Rennous-Kleinle Division of the Pittsburgh Plate Glass Co.,

3221 Frederick Ave., is planning for the erection of a 4-story addition to its plant, 75 x 205 ft., to be equipped primarily for the manufacture of plate glass.

BALTIMORE—The Aromo Mfg. Co., 308 South Hanover St., recently organized with a capital of \$100,000, is arranging for the establishment of a new plant for the manufacture of chemicals and affiliated products. Bids for equipment will be asked at an early date, including chemical machinery, mixing equipment, filtration apparatus, etc. Morris Bernstein is president, and Arthur W. Smith, vice-president and manager.

Michigan

PONTIAC—The Corodium Sand Brick Co., recently organized, has plans under way for the erection of a new plant on local property, and will break ground at an early date.

PORT HURON—The New Egyptian Portland Cement Co. has work under way on the remodeling and improving of the local shops of the Grand Trunk Railway Co., for a new cement mill, and will commence the installation of machinery at an early date. The property was acquired recently. Headquarters of the company are at 1213 Ford Bldg., Detroit. John Gillespie is president.

Missouri

MONETT—The Hammond Dehydration Co., J. H. Elpass, manager, will postpone for a number of months the erection of its proposed new plant, estimated to cost about \$50,000. Heckenlively & Mark, 642 Landers Bldg., Springfield, Mo., are architects.

New Jersey

BUTLER—The Bloomingdale Rubber Co. will make a number of improvements in its local plant for the manufacture of rubber specialties, and will remove the reclaimed rubber department to its works at Chester, N. J. The local plant will be enlarged and employment given to about 50 additional persons.

SAYREVILLE—Fire Feb. 25 destroyed a portion of the plant of the Sayre & Fisher Co., manufacturer of brick and other burned clay products, with loss estimated at about \$40,000.

TRENTON—The Henry R. Fell Co., East Carroll St., manufacturer of concrete roofing tile, will install additional equipment for increased production. J. Henry Fell is head.

New York

BROOKLYN—Fire Feb. 23 destroyed a portion of the plant of the Williamsburg Chemical Co., 230-2 Morgan Ave. An official estimate of loss has not been made.

BROOKLYN—J. M. Huber, 602 62nd St., manufacturer of colors, etc., has awarded a contract to Smith & Leo, 103 Park Ave., New York, for the erection of a 2-story addition, 36 x 52 ft., at the corner of 62nd St. and 6th Ave.

Pennsylvania

ELIZABETHTOWN—The Farmers' Fertilizer Works, William Schneitman, head, will soon commence the erection of a new plant building, 1-story, 90 x 140 ft.

PHILADELPHIA—The Wittman Moriarty Co., 4th and Vine Sts., manufacturer of leather products, has acquired property at Westmoreland and B Sts., as a site for the construction of a new plant, 75 x 105 ft., estimated cost \$75,000. The tract totals 240 x 350 ft., for future expansion, and was secured for a consideration of about \$30,000.

Tennessee

MEMPHIS—The National Waterproofing Co. is planning for the rebuilding of the portion of its plant, recently destroyed by fire with loss estimated at about \$175,000.

Texas

EASTLAND—Butler Bros. have acquired property on the J. L. Johnson tract, near the city limits, as a site for the immediate erection of a new gasoline absorption plant, with capacity of about 12,000 gal. per day. It will cost about \$300,000. This will be the first of a series of plants to be established by the company, with complete cost estimated at \$1,500,000.

Washington

SPOKANE—The Standard Stoneware Co., Spokane, Wash., is planning for the erection of a new pottery for the manufacture of earthenware and stoneware products, to cost about \$25,000. Charles Stormes is head.

Capital Increases, etc.

THE FILER FIBRE CO., Filer City, Mich., manufacturer of fiber products, has filed notice of increase in capital from \$450,000 to \$1,000,000.

THE SCOTT TILE CO., Paris, Tex., manufacturer of ceramic tile, has filed notice of increase in capital from \$15,000 to \$35,000.

THE ATOMIZED PRODUCTS CO., Evansville, Ind., has filed notice of increase in capital from \$200,000 to \$500,000.

THE SLAYMAKER ELECTRIC WELDING CO., Detroit, Mich., has filed notice of increase in capital from \$28,000 to \$50,000.

THE OXFORD PAPER CO., Rumford, Me., has arranged for a bond issue of \$5,000,000, the proceeds to be used for general operations. The company has completed negotiations for the purchase of the Rumford Falls Power Co. James A. Harris is general manager.

THE INDIANOMA REFINING CO., operating oil refineries at East St. Louis, Ill., and Okmulgee, Okla., has arranged for a note issue of \$900,000, for general operations, financing, etc.

Robert C. Rand has been appointed receiver for the ARISTA CHEMICAL CO., 305 Broadway, New York, N. Y.

THE HARRISON-WALKER REFRACTORIES CO., Pittsburgh, Pa., manufacturer of firebrick and other refractory products, has arranged for a decrease in capital from \$36,600,000 to \$30,000,000. A special meeting of stockholders will be held on March 16.

Plans are being perfected for a merger of the BUTTE-BULLWHACKER CO. and the BUTTE-DULUTH COPPER CO., both of Butte, Mont., operating local copper-leaching plants.

THE McGEARY FIREBRICK CO., Pittsburgh, Pa., has filed notice of dissolution under state laws.

THE OWOSSO BRONZE BEARING CO., Owosso, Mich., has filed notice of dissolution under state laws.

THE EXCELL BRASS FOUNDRY, 819 Frelinghuysen Ave., Newark, N. J., has filed notice of organization to manufacture brass, bronze and other metal castings. Thomas Proctor heads the company.

THE WALDO OIL CO., New York, N. Y., has been incorporated under Delaware laws, with a capital of \$100,000, to manufacture petroleum products. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

New Companies

THE MICHIGAN PORCELAIN TILE WORKS, INC., Ionia, Mich., has been incorporated with a capital of \$100,000, to manufacture floor and wall tile and other ceramic products. The incorporators are Royal A. Hawley, Harry E. Kidder and T. B. Duston, all of Ionia. The company will build a local plant.

THE SANITARY FIBER CO., 342 South Hoyne Ave., Chicago, Ill., has been incorporated with a capital of \$50,000, to manufacture fiber products. The incorporators are William W. Newell, R. F. Locke and Frank L. Childs.

H. F. SOMMER & CO., INC., Newark, N. J., has been incorporated with a capital of \$100,000, to manufacture leather products. The incorporators are Harry F. J. F. and William M. Sommer. The company is represented by Bilder & Bilder, 790 Broad St., Newark.

THE ALLIED PAPER MILLS, INC., New York, N. Y., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture paper products. The incorporators are S. B. Monroe, A. C. Gilman and F. A. Wagner. The company is represented by Davis, Wagner, Heister & Holton, Mutual Life Bldg., New York.

THE WON-DA PRODUCTS CO., INC., Hartford, Conn., has been incorporated with a capital of \$100,000, to manufacture soaps, oils, compounds, etc. The incorporators are H. L. Rose, A. Goldberg and Richard Ryder, 46 Capen St., Hartford.

THE PURITAN REFINING CO., New York, N. Y., has been incorporated under Delaware laws with capital of \$100,000, to manufacture refined oil products. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE OIL CITY LUBRICANTS CORP., 1401 Madison Ave., Baltimore, Md., has been incorporated with a capital of \$50,000, to manufacture oils, greases, etc. The incorporators are William S. F. A. and W. W. Pica.

THE UNDERCOAT PAINT CO., New York, N. Y., has been incorporated with a capital

of \$35,000, to manufacture paints, varnishes, etc. The incorporators are N. C. Latter, L. F. Kuntz and T. C. Tocknell. The company is represented by H. W. Kiralfy, 565 Fifth Ave., New York.

THE METUCHEN DYESTUFF CORP., Metuchen, N. J., has been incorporated with a capital of \$100,000, to manufacture colors, dyes, chemicals, etc. The incorporators are Saul Ceasar, Albert G. Rich and Alexander C. Connor, Durham Ave., Metuchen.

THE CONTINENTAL LEATHER CO., Wilmington, Del., has been incorporated under Delaware laws with capital of \$7,500,000, to manufacture leather products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE NONTOXO CHEMICAL CO., South Bend, Ind., has been incorporated with a capital of \$10,000, to manufacture chemicals and chemical byproducts. The incorporators are John A. King, M. G. Mock and Louis J. Smith, all of South Bend.

THE PLEASANT LAKE MARL CO., Three Rivers, Mich., has been incorporated with a capital of \$5,000, to manufacture lime and fertilizer products. The incorporators are Oliver T. Avery, F. A. Rohrer and M. W. Lott, all of Three Rivers.

THE ESSEX PAPER PRODUCTS CO., Lawrence, Mass., has been incorporated with a capital of \$25,000, to manufacture paper goods. Albert J. Quimby is president, and Daniel J. Crowley, Jr., Lawrence, treasurer.

THE GRAHAM REFINING CO., Graham, Tex., has been incorporated with a capital of \$30,000, to manufacture refined oil products. The incorporators are M. K. Graham, J. C. Kilgore and Thomas Morris, all of Graham.

THE CONSUMERS' COLOR & CHEMICAL CO., 1823 West Lake St., Chicago, Ill., has been incorporated with a capital of \$10,000, to manufacture chemicals, chemical byproducts, etc. The incorporators are Adam Heckmann, Samuel J. Heftl and Gustav Ruchelt.

THE BALTIMORE CEMENT PRODUCTS CO., INC., 525 Overland Ave., Baltimore, Md., has been incorporated with a capital of \$25,000, to manufacture brick, pipe, blocks and kindred products. The incorporators are Herbert L. and D. Lee Bowen, and George S. Hiller.

THE MATAWAN COLOR CO., Matawan Park, Matawan, N. J., has been incorporated with a capital of 600 shares of stock, no par value, to manufacture chemicals, colors, etc. The company is represented by Arthur W. Britton, 65 Cedar St., New York, N. Y.

THE BELLROSE STANDARD SILICA CO., Ottawa, Ill., has been incorporated with a capital of 3,500 shares of stock, no par value, to manufacture silica products. The incorporators are Robert O. Farrell, Holland M. Cassidy and Jesse Halsted, Ottawa. The company is represented by Chapman, Cutler & Parker, 111 West Monroe St., Chicago, Ill.

THE GOLD SEAL OIL CO., Reading, Pa., has been incorporated with a capital of \$110,000, under Delaware laws, to manufacture petroleum products. The incorporators are Charles E. Keyee, Reading; Samuel T. Newhardt and Paul F. Erdman, Allentown, Pa. The company is represented by the Corporation Service Co., Wilmington, Del.

THE GOHENE CORP. OF NEW JERSEY, Newark, N. J., has been incorporated with a capital of \$30,000, to manufacture paints, varnishes, etc. The incorporators are S. Michael Cohen, Manuel M. Voltt and Nathaniel X. LePeau, 202 Emmet St., Newark.

THE LOUIS MESKAN BRASS FOUNDRY, INC., 422 South Robey St., Chicago, Ill., has been incorporated with a capital of \$12,000, to manufacture brass, bronze and other metal castings. The incorporators are Louis Meskan and Edward Schauble.

THE BLUE DIAMOND MORTAR CO., 1007 Candler Bldg., Atlanta, Ga., has been incorporated with a capital of \$150,000, to manufacture lime and affiliated products. A. P. McCallie is president and general manager; and B. Graham West, secretary and treasurer.

THE KEYSTONE REFINING CO., Brooklyn, N. Y., has been incorporated with a capital of \$10,000, to manufacture oil products. The incorporators are C. D. and D. Flanel, and S. Glaser. The company is represented by E. M. Ostrow, 63 Park Row, New York.

THE RODGERS PRINTING INK CO., New York, N. Y., has been incorporated with a capital of \$10,000, to manufacture inks and affiliated products. The incorporators are J. E. and J. M. Rodgers, and T. F. Torley. The company is represented by J. A. Turley, 233 Broadway, New York.

CHRISTIAN FLEISSNER, INC., Newark, N. J., has been incorporated with a capital of \$150,000, to manufacture leather products. The incorporators are A. Fleissner, H. Croan

and Christian Fleissner, 125 New Jersey Railroad Ave., Newark.

THE OSSIE OIL CO., Tulsa, Okla., has been incorporated with a capital of \$100,000, to manufacture petroleum products. The incorporators are T. B. Reese, Eugene DeBorgory and W. Shillig, all of Tulsa.

THE UNITED STATES REFRACTORIES CO., INC., Boston, Mass., has been incorporated with a capital of \$200,000, to manufacture firebrick and other refractory products. Arthur W. Leavitt is president; and Dagmar Anderson, Dorchester, Mass., treasurer.

THE LIBERTY COLOR & CHEMICAL CO., Philadelphia, Pa., has been incorporated with a capital of \$25,000, to manufacture chemicals, chemical byproducts, etc. Thomas D. O'Brien, 3911 North Park Ave., Philadelphia, is treasurer.

THE COMMERCIAL CHEMICAL CO. OF TENNESSEE, Nashville, Tenn., has been incorporated with a capital of \$2,500,000, under Delaware laws, to manufacture chemicals and chemical byproducts. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del.

THE NEW SOUTHERN OIL CO., Dallas, Tex., has been incorporated with a capital of \$75,000, to manufacture petroleum products. The incorporators are C. U. Connelley and O. B. Colquitt, both of Dallas.

THE ORA-LEE CO., Wilkes-Barre, Pa., has been incorporated with a capital of \$30,000, to manufacture extracts, compounds, etc. John M. Walsh, Wilkes-Barre, is treasurer.

WISS SONS, INC., Newark, N. J., has been incorporated with a capital of \$300,000, to manufacture glass products. The incorporators are Frederick, C. J. and Jerome B. Wiss, 665 Broad St., Newark.

THE MAMMOTH OIL CO., Wilmington, Del., has been incorporated with a capital of \$100,000,000, under Delaware laws, to manufacture petroleum products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922. Headquarters will be at the Emerson Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its summer meeting at Niagara Falls, June 19 to 22. Headquarters will be at the Clifton Hotel.

AMERICAN SOCIETY FOR STEEL TREATING will hold a sectional meeting at the Bureau of Mines auditorium, Pittsburgh, Pa., on May 25 and 26. The International Steel Exposition and Convention of the society will be held in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

IRON AND STEEL INSTITUTE (British) will hold its annual meeting on May 4 and 5 at the House of the Institution of Civil Engineers, Great George St., S. W., 1, London.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettin Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists Club, New York: March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.